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Service Reference Library

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STUDEBAKER
Service Reference Library

A work of reference for the guidance of Studebaker Dealers

1927 Edition

Published by

General Service Department
THE STUDEBAKER CORPORATION OF AMERICA
South Bend, Indiana

FOREWORD

MOST Studebaker dealers are already familiar with the Studebaker Service Manual which was issued several years ago, so that this latest work needs little introduction. Incorporating information on the line of automobiles announced September 14, 1924, it should immediately take its place in the shop, beside the original book.

We wish to take this opportunity to thank the many Studebaker dealers who were interested enough to contribute their suggestions and ideas.

The new edition has grown to such proportions that the term "Service Manual" seemed inadequate and was therefore changed to "Service Reference Library." It has been separated into a number of different volumes, each volume covering only a portion of the car. Thus it is possible for several men to use it at once—one, for instance, using the volume on engines while others are making use of the book on transmissions or electrical equipment. The separate volumes, being smaller, are easier to handle and easier to keep up-to-date with new sheets.

Everyone in possession of one of these Libraries will be put on our mailing list to receive insert sheets covering new and revised instructions as issued. New instructions will go out on white paper while revisions in the present instructions will be printed on green paper. The use of these sheets is fully explained on pages 17, 59, 99 and 133.

We invite correspondence from everyone having suggestions that will make the Library more complete and of more value to our service men.

General Service Department,
The Studebaker Corporation of America,
South Bend, Indiana.

Volume One

BIG SIX, SPECIAL SIX AND BUS CHASSIS

FRONT AXLE, STEERING GEAR, REAR AXLE, PROPELLER SHAFT ALL MODELS

Unless otherwise specified the information herein given applies to all cars after Bix Six serial number 2,060,001, Special Six serial number 3,120,001, Standard Six serial number 1,202,001, Bus Chassis serial numbers 2,070,600 and 3,173,001 and Erskine Six.

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STUDEBAKER
Service Reference Library
In Nine Volumes

Volume One

Front axle, steering gear, rear axle and propeller shaft. All models.

Volume Two

Brakes, chassis, body and miscellaneous. All models.

Volume Three

Big Six, Special Six and Bus chassis engine and gasoline system.

Volume Four

Standard Six engine and gasoline system.

Volume Five

Erskine Six engine and gasoline system.

Volume Six

Transmission and Clutch. All models.

Volume Seven

Electrical equipment. All models.

Volume Eight

Service tools.

Volume Nine

Studebaker Service Bulletins.

BIG SIX, SPECIAL SIX AND BUS CHASSIS SECTION

DIAGNOSIS

THE following pages of diagnosis will be found of material value in tracing the sources of difficulty. The main headings have been taken directly from indications of trouble, such as "Tire Treads Worn Abnormally" or "Car Steers Hard." Under these have been listed the causes for such conditions. Even the most experienced mechanic will find that such a list will often serve to jog his memory on causes which are infrequently encountered. Sections on "Test" and "Remedy" then follow except in a few cases where these items are so apparent as to need no explanation. In case more detailed information on any subject is required the General Information Section starting on page 19 or the Operation Articles starting on page 61 should be consulted.

FRONT WHEELS

Tire Treads Worn Abnormally

Cause

1. Tires under-inflated.
2. Improper toe-in, resulting from—
   - Wrong adjustment of cross tube.
   - Cross tube sprung.
   - Cross tube and adjustable clevis threads worn (2-WB).
   - Cross tube ends loose on threads (4-WB).
   - Cross tube clevises or clevis bolts worn (2-WB).
   - Steering knuckle arm bushing worn.
   - Front axle sprung.
   - Front spring center bolt broken.
   - Steering knuckle arm bent.

Test

1. Check the air pressure, using a low pressure tire gauge if balloon tires are used.

2. Check the alignment with Front Wheel Aligning Gauge (C.O. 151, Vol. 8). The toe-in should be 1/8 inch for balloon tires and 1/4 to 3/8 inch for high pressure tires. Misalignment may also be indicated by a tendency of the car to go to one side of the road.

Remedy

1. Inflate the tires according to the pressures given on page 19.

2. Before adjusting the cross tube, check all parts mentioned to make sure nothing is loose or damaged. See Operation Article No. 8 or 9 to adjust the cross tube. *The cross tube should always be straightened cold. The front axle should also be straightened cold if possible. If not possible, it is advisable to replace it with a new one. See* Operation Article No. 19 or 20. The steering knuckle arm should be replaced with a new one if bent. See General Information, page 21.

Tires Do Not Run True

Cause

1. Rim not true, resulting from—
   - Rim lugs worn or drawn up unevenly.
   - Rim sprung.
   - Wheel felloe band damaged.
   - Tire wall weak causing lumps on tire.
2. Wheel not true, resulting from—
   - Wheel sprung.
   - Spokes loose (wood wheel).
   - Bearing loose or broken.

Test

1 and 2. Check by holding an indicator at the rim and at the wheel felloe, to determine which is running out and how much. A loose or broken bearing will be indicated by excessive play in the wheel. Also a broken bearing will be noisy.

Remedy

Draw up the rim lugs evenly in the rotation shown in Illus. No. 16. If worn they should be replaced.

Damaged wheels should be taken to a wheel wright or to a service station for the equipment in question.

If the bearings are in good condition but loose, they may be adjusted. However, if they are broken the cone and cup must both be replaced.

Front Wheel Noisy

Cause

1. Wheel rattles, resulting from—
   - Loose bearings.
   - Broken or pitted bearings.
   - Spokes loose in hub or felloe band (wood wheel).
   - Rim lugs worn or loose.
2. Wheel squeaks, resulting from—
   - Rim lugs worn or loose (wood wheels).
   - Wheel bearings dry.
   - Spokes loose in hub or felloe (wood wheel).
   - Wheel rim flattened.
   - Rusty or sprung tire retaining ring (disc wheel).
   - Dust washer retainer dry.
3. Bearings noisy, resulting from—
   - Bearings loose.
   - Bearings tight.
   - Bearings dry.
   - Bearings broken or pitted.
   - Bearings dirty.

Test

1. Jack up the front axle. Grasp the wheel by the top and bottom and check the play by attempting to move the wheel. See Illus. No. 15. Do not confuse play in the wheel bearings with play in the steering knuckle.

Rotate the wheel slowly. If it seems "rough" or the bearings rattle when the wheel is rotated, remove the wheel and examine the bearings.

Test the wheel hub bolts with a wrench. Also check by prying the spokes gently with a block of wood and noting play.

2. Test the wheel hub bolts for looseness with a wrench. Also check by prying the spokes apart gently with a block of wood and noting the play.

3. Jack up the front axle. Grasp the wheel by the top and bottom and check the play by attempting to move the wheel. See Illus. No. 15. Do not confuse play in the wheel bearings with play in the steering knuckle.

Rotate the wheel. It should rotate freely and retard slowly. A tight bearing or lack of lubrication would cause it to rotate with difficulty and retard rapidly. If this is the case or if it seems "rough" or the bearings rattle when the wheel is rotated, remove the wheel and check the adjustment and the bearings.

Remedy

Damaged wheels should be taken to a wheel wright or to a service station for the equipment in question.

If the tire retaining ring is rusty remove it and apply a small amount of oil or light grease. If the ring is sprung it is advisable to install a new one.

If the bearings are broken or pitted, both the bearing cone and the cup should be changed. Bearings which seem "rough" when rotated, but which appear to be in good condition are usually dirty. They should be thoroughly washed and repacked with medium grease.

Front Wheel Bearings Heat

Cause

1. Bearings dry.
2. Bearings tight.
3. Bearings broken or pitted.

Test

Jack up the front axle and rotate the wheel. It should rotate freely and retard slowly. A tight bearing or lack of lubrication would cause it to rotate with difficulty and retard rapidly. If this is the case or if it seems "rough" or the bearings rattle when the wheel is rotated, remove the wheel and check the adjustment and the bearings. A heavy grease will not lubricate in cold weather because it will not reach the bearing surfaces.

Remedy

If the bearings are broken or pitted, both the bearing cone and the cup should be changed.

Lubricate the bearings with a medium grease.

STEERING GEAR

Excessive Backlash

Cause

1. Steering knuckle or front wheel bearings loose.

2. Steering connections and joints loose, resulting from—

Cross tube clevises, clevis bolts or steering knucklt arm bushing worn (2-WB).
Cross tube clevis loose on cross tube (2-WB).
Cross tube ends loose on cross tube (4-WB).
Reach rod loose.
Steering arm loose on worm gear shaft.
Steering gear bracket loose in frame.
Steering gear case loose in bracket.

3. Worm gear shaft bushings worn.

4. End play in steering worm gear shaft, resulting from—

Adjustment needed.
Thrust ball broken.

5. End play in steering post, resulting from—

Loose bearings.
Broken bearings.

6. Excessive backlash between worm and worm gear, resulting from—

Worn teeth.
Adjustment needed.

Test

1. Jack up the front axle. Grasp the wheel by the top and bottom and check the play by attempting to move the wheel. See Illus. No. 15. Do no confuse play in the steering knuckle with play in the wheel bearings.

2. Test for looseness by placing the hand at each joint in succession while having someone move the steering wheel gently. Any excess play may thus be felt.

3. Attempt to move the worm gear shaft up and down in the bushings by means of the steering arm and note the play in the shaft.

4. Place the hand on the end of the worm gear shaft while having someone move the steering wheel slightly. If end play exists, the shaft will be felt to move endwise. A broken thrust ball, which rarely occurs, would result in a great amount of end play or, more likely, in binding of the steering gear.

5. Turn the steering wheel back and forth. If end play exists in the steering post, the steering wheel hub can be seen to move up and down at the upper end of the steering post jacket.

6. With the front wheels straight ahead, move the steering wheel back and forth just enough to take up the play in the gears. Repeat this with the wheels cramped to one side.

If the backlash is greater with the wheels straight ahead than when cramped to one side, the gear teeth are worn.

If the backlash is approximately the same in both positions, yet is excessive, it indicates need of adjustment.

Remedy

1, 2, 3, 4 and 5. The remedy in these cases is apparent and usually consists of replacing the worn or damaged parts or making adjustment.

6. If the gear teeth are only slightly worn a satisfactory adjustment can probably be made. However, if they are badly worn, remove the steering arm and give it a half turn on the worm gear shaft. This will engage new teeth on the gears. Then, if necessary, adjust the backlash by turning the gear case cover. See Operation Article No. 30.

Car Steers Hard

Cause

1. Tires under-inflated.
2. Improper toe-in, resulting from—
   - Wrong adjustment of cross tube.
   - Cross tube sprung.
   - Cross tube and adjustable clevis threads worn (2-WB).
   - Cross tube ends loose on threads (4-WB).
   - Cross tube clevises or clevis bolts worn (2-WB).
   - Steering knuckle arm bushing worn (2-WB).
   - Front axle sprung.
   - Front spring center bolt broken.
   - Steering knuckle arm bent.
3. Improper camber, resulting from—
   - Front axle sprung.
   - Steering knuckle spindle bent.
   - Steering knuckle bearing loose.
   - Wheel bearings loose.
4. Lack of lubrication in any part of steering mechanism.
5. Steering mechanism binding, resulting from—
   - Steering knuckle bearings too tight.
   - Cross tube clevises adjusted too tight or sprung (2-WB).
   - Reach rod adjusted too tight.
   - Worm gear shaft end play adjustment drawn up too tight.
   - Steering gear thrust bearings adjusted too tight.
   - Insufficient backlash between worm and worm gear.
   - Steering gear out of line in steering gear to frame bracket.
   - Worm gear shaft sprung.
   - Steering post sprung.

Test

Jack up the front axle and turn the steering wheel back and forth. If it turned hard when the car was moving but now turns freely with the front wheels off the ground, the causes will be found under items 1, 2 or 3.

If it turns hard with the front wheels off the ground, the causes will be found under items 4 or 5. After these have been eliminated, it should be tested for items 1, 2 and 3 which might be contributing to the stiffness of the steering with the car in motion.

1. Check the air pressure, using a low-pressure tire gauge, if balloon tires are used.

2. Check toe-in with the Front Wheel Aligning Gauge. (See C. O. 151, Vol. 8). If the car is equipped with balloon tires the wheels should be 1/8 of an inch closer together in front than in the rear, measured at the wheel felloe. For high pressure tire equipment the toe-in should be 1/4 to 3/8 of an inch. Also test each point mentioned for looseness or check for being bent.

3. The front wheel camber can be checked by placing the car on a level floor and using a large square. Place the square on the floor as in Illus. No. 17, and measure from the top of the square to the top of the wheel felloe. Then measure from the bottom of the square to the bottom of the wheel felloe. The lower measurement should be 3/4 to 1 1/4 of an inch greater than the upper measurement.

An accurate measurement cannot be obtained with excessive play in the wheel or steering knuckle bearings. See that these are properly adjusted.

4. If lack of lubrication is the cause of stiffness, the parts should free up on being properly lubricated. In some cases it may be necessary to take them apart and clean them.

5. Parts which are stiff or are adjusted too tight must be found by a process of elimination.

First remove the rear end of the reach rod from the steering arm. Now try the steering wheel and also move the front wheels, with the axle jacked up. This will determine whether the difficulty lies in the steering gear assembly or in the front axle mechanism or whether both are at fault.

The reach rod connections can be tested at the same time.

By disconnecting the cross tube, the steering knuckle bearings and cross tube connections can be individually checked.

If the steering gear assembly seems stiff, each adjustment, in turn, can be loosened and the effect noted.

A sprung steering post or one out of line, will cause the steering gear case to move perceptibly when the steering wheel is turned.

If the cause of stiffness is not by this time apparent, the steering gear assembly should be removed and inspected for sprung or damaged parts.

Remedy

1. Inflate the tires according to the pressures given on page 19.
2. Before adjusting the cross tube for toe-in, check all parts mentioned to make sure nothing is loose or damaged. See Operation Article No. 8 or 9, to adjust the cross tube.

The cross tube always should be straightened cold. The front axle should also be straightened cold if possible. If not possible, it is advisable to replace it with a new one. The steering knuckle arm should be replaced with a new one if bent.

3. *The front axle should be straightened cold if possible. If not possible it is advisable to replace it with a new one.*

If the steering knuckle spindle on 4-wheel brake equipment is bent, it may be replaced. However, if the car has 2-wheel brake equipment it will be necessary to replace the complete steering knuckle. *Do not attempt to straighten these parts.*

5. Most of these difficulties can be eliminated by proper adjustment. See the operation articles for this.

The worm gear shaft and the steering post are rather difficult to straighten and a dial reading indicator (C. O. 63) is an absolute necessity to assure perfect results. Be sure that any straightening attempted is done without heat.

Steering Gear Rattles

Cause

1. Excessive backlash in steering mechanism. See page 8.
2. Steering post loose in steering post jacket upper bushing.
3. Steering post jacket clamp loose.
4. Throttle and lighting switch lever tubes loose.
5. Insufficient or incorrect lubricant used in steering gear housing.

Test

1. See page 8.

2 and 3. Play in the jacket bushing or in the lower end of the jacket can usually be detected by attempting to rattle the jacket.

4. If the tubes are loose they can usually be moved back and forth in the steering post.
5. See 'Remedy," "Item 5."

Remedy

1. See page 9.

2 and 3. If the jacket bushing is loose, a new one will be required. The lower end may be tightened by drawing upon the clamp.

4. If the babbitt bushings are worn, a new steering post and throttle lever tube will be required.
5. A very heavy transmission oil should be used in the steering gear.

SPRINGS

Springs Squeak

Cause

1. Lack of lubrication of spring shackles and bolts.
2. Main spring clips loose.

Springs Rattle

Cause

1. Loose or worn shackles and spring bolts.
2. Spring hanger loose on frame.
3. Loose spring clips.

Test

1, 2 and 3. Looseness at these points will cause a pronounced rattle or knock as the car is driven over a rough road or drops into a hole in the road.

Remedy

1. Loose spring shackles may be tightened but if the spring bolts are worn the only remedy is to replace the bolts and bushings.
2. If the spring hanger rivets have loosened they must be replaced with new ones.
3. The main spring clips should be drawn up with a heavy wrench.

REAR AXLE

Tire Treads Worn Abnormally

Cause

1. Tires under-inflated.
2. Rear wheels out of line, resulting from—
   - Rear axle housing sprung or broken.
   - Spring center bolts sheared.
   - Frame bent or broken at rear end.
   - Spring master leaf broken.

Test

1. Check the pressure, with a low pressure tire gauge if balloon tires are used.

2. Check by measuring from the center of front wheel spindle to the center of the rear axle shaft on each side. These measurements should be the same with the car on a level floor and the front wheels pointing *straight ahead.* Also check real wheel alignment with the Front Wheel Aligning Gauge, C.O. 151.

This condition may also be indicated by a tendency of the car to go to the side of the road. This is not a positive indication, however, as front wheels out of line give the same effect.

If the housing is badly sprung, the axle shaft will bind (where it enters the differential side bevel gear) when attempting to remove or install it.

Remedy

1. Inflate the tires according to the pressure given on page 19.

2. If the rear axle housing is only slightly sprung, it may be cold straightened in a heavy press. If badly sprung or broken, a new housing will be necessary. *Never use heat in straightening this part.*

The frame, if broken, should be replaced with a new one to make the most satisfactory repair. However, it can sometimes be repaired. When sprung it may be heated, if necessary, to a *dull red* to straighten it.

Tires Do Not Run True

Cause

1. Rim not true (wood wheel), resulting from—
   - Rim lugs worn or drawn up unevenly.
   - Rim sprung.
   - Wheel felloe band damaged.
   - Tire wall weak causing lumps on tire.
2. Wheel not true, resulting from—
   - Wheel sprung.
   - Spokes loose (wood wheel).
   - Axle shaft sprung.
   - Axle shaft bearings broken.
3. Wheel not drawn up tight on shaft.

Test

1 and 2. Check by holding an indicator at the rim and also the wheel felloe to determine which is running out and how much.

If it is found that the wheel is not running true, apply the indicator to the axle shaft to determine whether it is sprung. A loose or broken bearing will be indicated by excessive play in the shaft. Also a broken bearing will be noisy. 1/8 of an inch run out at the wheel felloe is permissable.

3. The axle shaft nut should be tested with a heavy wrench.

Remedy

Damaged wheels should be taken to a wheel wright or to a service station for the equipment in question.

If the rear axle shaft is sprung it should be replaced with a new one, unless the damage is very slight, in which case it may be straightened cold. *Never apply heat for straightening.*

If the bearings are in good condition but loose, they may be adjusted. However, if they are broken, the cone and cup must both be replaced.

Rear Wheels or Axle Shafts Click When Applying Power

Cause

1. Wheel loose on axle shaft.
2. Rim lugs loose (wood wheels).
3. Wheel stud nuts loose (disc wheels).
4. Axle shaft key or key way in shaft or wheels hub worn.
5. Excessive end play in rear axle shafts.
6. Splines worn, on inner end of axle shaft.

Test

1. Test the axle shaft nut with a heavy wrench.
2. Test the rim lugs with a rim wrench.
3. Test the stud nuts with a disc wheel socket wrench.
4. Remove the wheel and examine the key and keyways for wear.
5. Jack up the axle and check the end play by attempting to move the wheel or shaft in and out. End play should be just barely perceptible or about .002 inch.
6. Remove the wheel and check the play by gently oscillating the axle shaft. Also remove the shaft and inspect for wear.

Remedy

4. Install a new key. If the key way in the wheel hub or in the shaft is worn excessively, these parts must be replaced.

5. See Operation Article No. 42 for adjustment of rear axle shaft bearings.

6. If the splines are worn, the shaft and possibly the differential pinion must be replaced.

Grease Leaks Past Rear Axle Shaft Bearing

Cause

1. Grease level too high in axle housing.
2. Overflow pipes plugged up.
3. Grease retainer washers broken or worn.

Test

1. Remove the plug in the rear axle housing cover. If grease flows out, it is because there is too much in the housing.

2. Clear the overflow pipe with a small stick or wire.

3. Remove the axle shaft and examine the grease retainer washers.

Remedy

1. Allow the grease to run out of the axle housing until the level is even with the filler hole.

2. Replace the washers if worn.

Rear Wheels Do Not Turn with Engine Running and Transmission in Gear

Propeller Shaft does not Turn

Cause

1. Clutch slips. See Vol. 6.
2. Transmission pinion broken.
3. Transmission pinion teeth sheared.
4. Transmission main or countershaft broken.
5. Transmission gear teeth sheared.
6. Transmission shaft flange key sheared.
7. Propeller shaft broken.

Test

1. With brakes firmly applied, transmission in high gear and engine running moderately, the clutch, when engaged, should hold sufficiently to stop the engine. See also Vol. 6.

2. Remove the hand hole cover in the bell housing and examine the pinion.

3, 4 and 5. Remove the gear shift base and examine the transmission gears.

6. Remove the gear shift base to see if the transmission shaft is turning.

If the shaft is turning but the flange is not, this would indicate a sheared flange key.

Remedy

1. See Vol. 6.

2, 3, 4, 5, 6 and 7. Broken or sheared parts must be replaced. Inspect all related parts for damage before making replacement. See the Operation Articles in Vol. 6, for this work.

Propeller Shaft Turns

Cause

1. Rear axle shaft key sheared.
2. Rear axle shaft broken.
3. Rear axle pinion shaft flange key sheared.
4. Rear axle pinion, ring gear or differential gear teeth broken.

Test

1. Remove the wheel to inspect.
2. Remove the axle shaft to inspect.
3. Remove the flange to inspect.
4. Remove the rear axle housing cover to inspect.

Remedy

1. Replace the key. Inspect the wheel hub and axle shaft for damage and replace these parts if necessary.

2. Replace the shaft. Do not attempt to weld a broken axle shaft.

3. Replace the key. Inspect the flange and pinion shaft for damage and replace these parts if necessary.

4. Replace broken parts. Inspect the assembly carefully for misalingnment before putting in new parts.

Rear Axle Noisy

Cause

1. Loose pinion or differential bearings.

2. Improper adjustment of differential and pinion gear assembly.

3. Pinion or differential bearing adjustment threads worn or broken.

4. Pinion or differential bearings pitted or broken.

5. Ring gear does not run true, resulting from—

Loose or broken differential bearings.
Differential case sprung or broken.
Ring gear bolts drawn up unevenly.
Ring gear warped or broken.

6. Ring gear and pinion not matched.

7. Rear tires noisy.

8. Tire chains in snow may cause objectionable noise in axle.

Test

1. An axle which is noisy from loose bearings, will ordinarily have become noisy gradually.

The pinion can be tested for end play by grasping the pinion flange and attempting to move it endwise or tapping it with a lead hammer. In order to check the differential bearings the rear axle housing cover must be removed. If the pinion bearings are found loose due to wear, it is usually safe to assume that the differential bearings are also loose.

A good way to determine whether the pinion and differential bearings are loose is to attempt to adjust them.

2. Before making any check on the adjustment of the gears, be sure the bearings are free from play. See Item 1.

If the adjustment of the gears is at fault and all other conditions are correct, the noise will usually be even. If it is not even, check items No. 3, 4 and 5.

In general, if the gears are noisy on the coast, it indicates that the ring gear is too far from the pinion, giving too much backlash.

If the gears are noisy on the drive, or both coast and drive, the ring gear may be meshing too tight with the pinion or the pinion adjustment may be improperly made.

3. If the threads of the pinion or differential bearing adjustment are worn or broken this will give about the same effect as a loose bearing.

Worn threads will be indicated by the adjusting nut being loose in the case. Check the clamp bolt to see that it is not loose.

Broken threads will be indicated by the adjusting nut sticking when being turned. If this condition is suspected, the nut should be removed for inspection. See that the clamp bolt is loosened before attempting to turn the nut.

4. Rotate the pinion and differential. They should move freely and smoothly. If they seem rough or rattle when rotated, remove the bearings for examination.

5. This will be indicated by an uneven noise from the gears.

Loose bearings may be detected by attempting to shift the differential assembly sidewise.

If the bearings are broken they will be rough or noisy when the assembly is rotated.

If the bearings are in proper condition, check the ring gear with an indicator to see if it is running true. If the ring gear is running out of true remove the differential assembly, take off the ring gear and then replace the differential.

Adjust the differential bearings and then check the flange of the differential case to see if it is running true.

Lay the ring gear on a surface plate, teeth up, and check for warp by trying to insert a .003 inch feeler between the gear and the surface plate. The feeler should not go under at any point.

If the differential case is not true, see if the two parts of the case are assembled so that the numbers or marks stamped along the joining edges (see Illus. No. 45) come directly opposite each other. If it is properly assembled and still runs out of true, then the case is sprung.

6. When all parts of the assembly seem to be in perfect condition and still a quiet adjustment of the ring gear and pinion cannot be obtained, the difficulty may lie in the gears not being matched. This could result from failure to install a matched pair when putting in new gears or an attempt to use one new gear with a worn one.

7. Certain types of tire treads often give a sound similar to gear noise. This can be determined by changing the rear tires to a different type, if possible a smooth tread.

Remedy

1. See Operation Article No. 49 for proper adjustment of the pinion and differential bearings.

2. Adjust the ring gear to give a backlash of .005 to .008 of an inch.

Test the axle and if noisy on the drive, adjust the pinion to pull it away from the ring gear, a notch or two at a time, until the adjustment is satisfactory.

If noisy on the coast, adjust the pinion to move it toward the ring gear until the adjustment is satisfactory.

If a proper adjustment cannot be obtained, remove the differential carrier with gears complete, thoroughly clean the grease from the gear teeth and check the tooth bearing as described in Operation Article No. 49.

See also Item No. 6, Page 14.

3. This can usually be remedied by installing new adjusting nuts. However, if the threads in the differential carrier are badly worn or damaged beyond repair a new carrier must be installed.

4. Pitted or broken bearings must be replaced with new ones. Replace the bearing cup at the same time.

5. See Item 4 for broken bearings.

If the ring gear is warped or broken a new one will be required. See Item 6.

If the two halves of the differential case are improperly assembled the case will not run true. If the numbers or marks on the joining edges do not come directly opposite each other reassemble the case so that they do. Then assemble the case in the axle, without the ring gear and test again for alignment.

If the differential case is broken a new one will be required. However, if the case is sprung this

can often be remedied by mounting it in a lathe and taking a cut off the surface to which the ring gear bolts. This method will be satisfactory if only a light cut is necessary. If the case is badly sprung, so that a heavy cut would be necessary to true it up, it would be advisable to install a new case rather than weaken the flange by removing too much stock.

If the ring gear and differential case test true individually and are not cracked, then the difficulty probably lies in the ring gear bolts being drawn up unevenly or in dirt between the gear and the case flange. The gear and the flange should be carefully cleaned and the gear reassembled, drawing the bolts up gradually and uniformly. Then replace the assembly and test again.

6. When necessary to replace either ring gear or pinion, both should be installed, using a set which has been matched and wired together at the factory. These come as an assembly under one part number.

7. No harm will be done by tires with noisy treads and the decision as to whether they shall be replaced with others of a different type should rest entirely with the owner.

PROPELLER SHAFT

Universal Joints or Propeller Shaft Noisy

Cause

1. Lack of lubrication, resulting from—
   Failure to lubricate at proper intervals.
   Joints leak grease.
2. Splines in sliding joint or on shaft worn.
3. Sliding joint improperly assembled to shaft.
4. Joint cross and bushings worn.
5. Propeller shaft sprung, resulting from—
   Improper use of clutch.
   Excessive backlash in transmission line.

Test

1. See under main heading "Universal Joints Leak Grease."

2. Play in the splines can be checked by attempting to oscillate the sleeve on the shaft.

3. Examine the sleeve and shaft to see if the arrows on each are opposite each other. If they are not the joints will not operate freely.

4. Oscillating or shaking the joint yoke will show whether play exists.

5. That the shaft was sprung due to improper use of the clutch will be difficult to determine. It should, however, be considered as one of the possible causes.

To check the backlash in the transmission line, jack up one of the rear wheels and place the transmission in high gear. Oscillate the rear wheel just enough to take up all play between the wheel and the engine. With all parts new and in good condition there should be a movement of 1″ to 1½″ measured on the circumference of the tire. On a car which has seen some service, however, slightly more than this is to be expected. If the total backlash appears excessive, check each assembly separately to determine where the play exists.

Remedy

1. See under main heading "Universal Joints Leak Grease."
2. Worn splines can be remedied only by installing a new universal joint yoke or propeller shaft or both.
3. Assemble the sleeve and shaft so that the arrows line up.
4. A new cross and bushings must be installed.
5. Backlash usually is caused from worn gear teeth or splines and can only be remedied by the installation of new parts. Also see Vol. 6.

Universal Joints Leak Grease

Cause

1. Improper lubricant used.
2. Too much lubricant applied.
3. Joint casings dented or bent.
4. Outer casing dust packing damaged, worn or missing.
5. Oil plug loose or missing.
6. Outer casing retainer spring weak.
7. Paint on inner casing.
8. Flange bolts loose.
9. Dirt between casing flange and flange yoke.
10. Sliding joint yoke sleeve improperly assembled to shaft.

Test

1. Use of ordinary oil or grease will result in lack of lubrication inasmuch as the joints will not retain this type of lubricant. Examine to see that Spicer Universal Joint grease or equivalent fibrous grease is used.
2. Examine to see that the joint is filled not more than one-third full. More than this is very liable to cause the grease to leak out.
3. Examine the casings to see that they are not dented or bent at points where grease could leak out.
4. Examine the packing.
5. Examine the grease plug to see if it is loose or missing.
6. Examine the spring to see if it holds the outer casing against the inner casing with sufficient pressure to retain the grease.
7. Inspect the inner casing for paint which would form an uneven surface between the casings and would pass grease.
8. Test the bolts with a wrench.
9. If the casing flange does not seem to be a tight fit at the flange yoke inspect for dirt which would prevent it seating.
10. Examine the shaft to see if the arrows on the sleeve and the shaft line up.

Remedy

1. Use Spicer Universal Joint grease or equivalent.
2. Fill joint only one-third full of grease.
3. It is very difficult to bump out the casings so that they will be grease-tight. Therefore, unless the damage is very slight, new casings should be installed.
4. Install new packing if necessary.
5. Tighten the grease plug or put in a new one if missing. Be sure to install the cotter pin.

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Do not turn the plug down so far that it will strike the yoke lug inside the casing.

6. Stretch the spring to give more tension or install a new one.

7. Clean all paint carefully from the inner casing and polish casing with fine emery cloth.

8. Draw the flange bolts up tight.

9. Remove or back off the casing and clean out all dirt carefully from between the casing flange and the flange yoke.

10. Assemble the sleeve to the propeller shaft so that the arrows line up.

GENERAL INFORMATION

The following section is one containing information of a general nature and may be used to supplement the Diagnosis and Operation Article Sections. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised paragraph will be carried at the bottom of the green sheet.

For example, the reader is interested in paragraph 3-B, Lighting Switch Lever. Before he reads this, a glance at the bottom of the page will tell him whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the paragraph Number 3-B, such as 3-B-1 or 3-B-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

FRONT AXLE

1-A—Tire Pressure

Passenger Cars—The air pressure in the tires must be accurately maintained to the figure given on the windshield sticker furnished with new cars. If the tires are run under-inflated, much undue friction will occur at the tread, causing rapid wear.

A table of proper pressures, for front and rear tires, for average passenger load divided into body models is given below.

BIG SIX (127 INCH WHEELBASE)

	Front	Rear
Duplex Tourer	38	30
Folding Top Tourer	38	30
5-pass. Coupe	38	30
Sedan (7-pass.)	38	32
Berline	38	32
Brougham (5-pass.)	38	32
The President	38	32

BIG SIX (120 INCH WHEELBASE)

Sport Phaeton	38	30
Duplex Roadster	38	30
Sport Roadster	38	30
Fire Chief Roadster	38	30
Sedan	38	36
Club Coupe	38	32
Custom Brougham (32x6.00 tires)	38	36
Custom Victoria (32x6.00 tires)	38	32
Commander Sedan (31x5.25 tires)	40	38
Commander Victoria (31x5.25 tires)	40	36
Commander Coupe (31x5.25 tires)	40	36

SPECIAL SIX

Duplex Phaeton	38	31
Duplex Roadster	38	30
Sport Roadster	38	30
Coach	38	32
Victoria	38	32
Brougham	38	36
Sedan	38	38

These pressures must be maintained and frequently checked with a low pressure tire gauge. If the car is used more with full passenger load than otherwise, these pressures must be increased. Consult the tire company in this case.

Busses—The proper air pressure for busses using 34 x 7.30, 6-ply, semi-balloon tires on the front wheels, depends upon the weight of the body, number of passengers, amount of baggage, etc. A table divided according to the load on each individual tire, is given below. The load on the front and rear axles should be weighed separately and these figures divided by 2 to give the load on each tire. The tire should then be inflated to the corresponding pressure. The following figures apply only to 34 x 7.30, 6-ply, semi-balloon tires.

Load	Tire Pressure
1450	36
1600	40
1800	45
2000	50

The figure should be chosen which represents average load. These pressures must be maintained and frequently checked with a low pressure tire gauge. If the bus is used more with full passenger load than otherwise select higher figures which will represent a good average and maintain these pressures.

The 34 x 7 high pressure tires used on the rear wheels require a pressure of 100 pounds regardless of load. The 32 x 6 high pressure tires used on dual wheel equipment should be inflated to 90 pounds regardless of load.

2-A—Cross Tube Broken or Sprung

A broken cross tube "K" (Illus. No. 6) is a very rare thing, as it will stand exceptional strains without breaking. However, in case the wheels are bumped against the curb or strike exceptionally rough places on the road, the cross tube may become sprung.

In the majority of instances it will be possible to straighten the cross tube after it has been removed. *This work must be done without applying heat.*

The cross tube on 2-wheel brake equipment is constructed with a slight downward and forward bend at the center to allow for dust pan clearance so do not consider this as meaning a damaged tube The cross tube on 4-wheel brake equipment is perfectly straight.

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To remove and replace the cross tube see Operation Article No. 5 or 6.

3-A—Cross Tube Clevis Bolts and Bushings Worn

(2-Wheel brake equipment.)

After the car has been in service for some time, wear will develop on the cross tube clevis bolts and bushings and occasionally on the cross tube clevises. One of these clevises is permanently fastened to the cross tube, the other being adjustable.

If the stationary clevis requires adjustment, it will be necessary to install a new cross tube.

To replace worn steering knuckle arm bushings, see Operation Article No. 12.

4-A—Cross Tube Ends Loose

(4-Wheel brake equipment)

There may be cases where the cross tube ends will become loose on the cross tube. This will usually be found to be due either to the clamp bolt being left loose or not enough of the thread being engaged in one end.

When the proper amount of thread is engaged the end of the cross tube will be visible in the sight hole "I" (Illus. No. 6 and 20) in each cross tube end. If this is not the case, see operations 4 and 5, Operation Article No. 9.

5-A—Cross Tube Clevis Loosening on Cross Tube

(2-Wheel brake equipment)

If the cross tube clevis has become loose on the tube, this will usually be found due to the clevis clamping bolt not being kept properly tightened.

If tightening the clevis clamping bolt will not tighten the clevis on the tube, it will be necessary to replace either the clevis or the tube or possibly both if the threads are badly worn. See Operation Article No. 5.

6-A—Front Axle Broken

The breaking of a front axle is something that very rarely occcurs, but in such an event the old axle must be removed and replaced with a new one. Under no circumstances, attempt to weld a front axle.

See Operation Article No. 19 or 20 for removing and replacing the front axle.

7-A—Front Axle Sprung

An axle can only be sprung on account of an accident and if not sprung to any great extent can be straightened and placed in serviceable condition.

Whenever possible, axles should be straightened cold by means of a heavy press. If the axle cannot be straightened cold a new one should be installed. *Do not attempt to straighten by heating.*

See the Front Axle Aligning Fixture, Vol. 8, for checking the alignment of the axle when straightening. Work of this nature should be done only at the owner's risk. The best and only recommended plan in case of a sprung axle is to install a new one to insure strength and perfect alignment.

See Operation Article No. 19 or 20 for removing and replacing axle.

8-A—Front Wheel Spindle

(4-Wheel brake equipment)

The front wheel spindle, on four-wheel brake equipment, is separate from the steering knuckle and is carried on a taper and held in place by a castellated nut. See Illus. No. 2.

It is necessary that this be a very tight fit in the steering knuckle to prevent it loosening.

If it should ever be necessary to remove the spindle (as in case of an accident) the nut should not be relied upon to tighten it when replacing it. A large arbor press should be used and the spindle should be pressed in under as heavy pressure as possible before drawing up the nut.

9-A—Front Wheel Alignment

It is very important to have the front wheels properly aligned, otherwise the tires will wear rapidly. Particular attention should be paid to the fact that the proper toe-in is not the same for balloon tires as for high pressure tires.

To check the alignment, use an aligning fixture such as is described under C. O. 151 in Vol. 8. The measurement taken at the front of the wheels should be 1/16 to 1/8 inch less than that taken at the rear with balloon tires and from ¼ to ⅜ of an inch less with high pressure tires.

See Operation Articles No. 8 and 9 for adjusting the cross tube to give the proper toe-in.

10-A—Adjusting Turning Radius

It is important that the turning radius be properly adjusted so that the car can be turned in the

minimum amount of space, without the wheels coming in contact with springs, fenders, reach rod or brake rods when turned in the extreme positions.

To make the adjustment, turn the steering knuckle stop screw at each end of the axle. When properly adjusted, the left tire in the case of left-hand control and the right tire in the case of right-hand control will clear the reach rod (also the brake rod on four-wheel brake equipment) by ½ to ¾ of an inch when the front wheels are turned to the extreme positions. See Illus. No. 14. The left or right tires on right or left-hand control respectively should clear the fenders and springs by the same amount when the front wheels are turned to the other extreme position.

After the correct adjustment is obtained, see that the stop-screw lock is tightened.

11-A—Front Wheel Camber

The front wheels, for ease in steering, are given a camber of 2°. This is accomplished, on 2-wheel brake cars, by tipping the steering knuckle spindle, while on 4-wheel brake cars both the spindle and the axle end are tipped resulting in the wheels being approximately 1¼ inches closer together at the bottom than at the top.

The front wheel camber can be checked by placing the car on a level floor and using a large square. Place the square on the floor as in Illus. No. 17, and measure from the top of the square to the top of the wheel felloe. Then measure from the bottom of the square to the bottom of the wheel felloe. The lower measurement should be ¾ to 1¼ inches greater than the upper measurement.

An accurate measurement cannot be obtained with excessive play in the wheel or steering knuckle bearings. See that these are properly adjusted.

12-A—Reach Rod Sprung

A reach rod will only become sprung in case of an accident, as this part is made amply strong to withstand shocks received in ordinary service.

If the rod is found to be only slightly sprung it can be straightened cold. Under no circumstances should heat be applied in straightening as this would destroy the the effects of the original heat treatment and make it unsafe to use.

If badly sprung it is advisable to install a new rod rather than attempt to straighten it.

For removing and replacing the reach rod see Operation Article No. 14.

13-A—Reach Rod Ball Bolt Broken

A broken ball bolt is usually caused by the car having been in an accident or failure to keep the nuts tight that hold these parts in place. If allowed to remain loose, breakage will be caused by an undue amount of strain on the ball through steering the car.

To replace a broken ball see Operation Article No. 15.

14-A—Reach Rod Spring Broken

A broken reach rod spring may be caused by improper adjustment of the reach rod plug, springing of the reach rod or lack of lubrication.

To install a new spring, see Operation Article No. 14.

15-A—Steering Knuckle Arm Sprung or Broken

If the steering knuckle arm is sprung or broken it will be necessary to install a new arm as it is impossible to satisfactorily straighten or weld this part. Do not attempt it.

See Operation Article No. 10 or 11 for replacement.

TAPER ROLLER BEARINGS

16-A—Adjustment

The adjustment of taper roller bearings is a matter of extreme importance as a bearing can be quickly ruined by improper adjustment.

When properly adjusted, the wheel or whatever part the bearing is mounted on, should turn perfectly free. The adjustment should be just a trifle on the loose side, that is, there should be a very slight amount of play in the bearing.

Adjusted in this manner the bearings will give maximum service.

17-A—Broken Bearings

Broken bearings are usually caused by lack of lubrication or by improper adjustment.

In case of a broken bearing, the cup should always be carefully inspected to make sure it is not damaged. In nearly all cases it will be necessary to install a new cup.

STEERING GEAR

1-B—Backlash or Play in Steering Mechanism

Backlash in the steering mechanism is due to wear or loose adjustment. Excessive wear is inevitable unless all parts receive proper lubrication and are properly adjusted.

Wear or loose adjustment of the steering mechanism will be indicated by an excessive amount of lost motion at the steering wheel.

It is not advisable to attempt adjustment of steering gear with no backlash whatever, as too much rigidity will result in undue wear and difficulty in steering.

Backlash amounting to a travel of ¾ to 1½ inches on the rim of the steering wheel is advisable. See page 8 for causes of excessive backlash.

2-B—Backlash Between Worm and Gear

Although there is provision for adjusting the clearance between the worm and worm gear, this cannot be used to compensate for worn teeth inasmuch as the teeth do not all wear the same amount. There is always more wear on the teeth engaged when the front wheels are in the straight ahead position than on those engaged when the front wheels are cramped to one side.

Therefore, if the teeth are worn it will be necessary to remove the steering arm and give the worm gear a one-half turn, causing new teeth to be in mesh before making the worm gear adjustment. See Operation Article No. 30.

3-B—Lighting Switch Lever

If the lighting switch or the lighting switch upper lever bracket on the steering wheel is removed, care must be taken in assembling that the positions of contact in the switch correspond to the lettering on the lighting switch upper lever. See Operation Article No. 27.

SPRINGS

4-B—Broken Springs

It is a common belief that the breakage of a spring occurs by a load pressing down on the spring, as when the car goes into a rut or hole in the road. As a matter of fact, when the spring gives way under these conditions, the breakage usually takes place on the rebound and not on the downward movement. On the downward movement the load is carried by all the spring leaves together, while the rebound force is taken up by the leaves singly, one after the other. For the latter reason it becomes evident that if rebound clips "A" (Illus. No. 35) are loose the strain on any one leaf at the time of rebound is increased and breakage is more liable to take place than when the clips are kept tight.

Breakage of spring leaves at a point between the two main clips "C" (Illus. No. 17) is considered by all spring manufacturers as being caused by the main clips not being kept tight.

The main clips on both front and rear springs should be inspected frequently (more especially during the first few hundred miles on a new car) and drawn up tight by means of a heavy wrench.

Breaking of springs can frequently be traced to overloading the car and running over rough roads, such as is experienced in bus line or taxi work.

Springs are made to stand a normal load with a reasonable overload at times but cannot be expected to stand up under continuous overloading and running over rough roads.

5-B—Spring Center Bolt Broken

Spring center bolts breaking or shearing can usually be traced to loose main spring clips or a heavy blow on the axle or wheels. This will cause the axle to slide out of line.

6-B—Spring Bushings

From time to time we have received comments on the fact that we furnish our spring bushings with a considerable amount of reaming stock, the suggestion usually being offered that it would simplify installation considerably were we to decrease this amount of extra work.

At the time of releasing Service Tool CO-200, Spring and Shackle Bolt Bushing Reamers, we went into the matter very carefully with the idea of reducing to the minimum the number of special tools required.

18-A—Reach Rod Lubrication

A new type of reach rod has been placed in production on all Commander models starting with serial 4011023. Medium to heavy engine oil is required for lubrication instead of grease.

This reach rod contains a plug at each end which are removed to fill the rod with oil. A wick in the rod insures a supply at the bearing surfaces.

The rod is designed so that it will retain this grade of oil and refilling is ordinarily necessary but once every six months. Heating the oil will facilitate filling the rod as it will flow much more freely.

7-B—Cushioned Steering Arm

Big Six cars after serial number 2113151 were equipped with a cushion type of steering arm. This arm contains a torsional rubber cushion, provided with positive stops and provision for adjustment.

Adjustment is by means of eight screws and the arm is set in production so that 300 pounds pressure applied at the end of the arm causes approximately one degree deflection of the rubber cushion.

If necessary after considerable use, these adjusting screws may be tightened uniformly one-half turn to compensate for wear. If a tendency to "kick back" at low speeds is noticed, it will be necessary to back off the screws uniformly one-half turn. In cases where springs have been excessively lubricated or fitted with boots, it may be found that the arm does not satisfactorily reduce steering wheel shocks. In these instances the springs should be removed and all lubricant washed out from between the leaves.

It is important that wheel alignment and spindle castor angle be properly adjusted or unstable steering at high speeds may be observed.

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We found that regardless of great care taken in the manufacture of our springs, there is bound to be some irregularity in the shape of the spring eye. We also found that due to this condition when the bushing is pressed into the spring eye it is usually distorted. If the bushings were made with only a few thousandths reaming stock they would not clean up when reamed and would not offer a perfect bearing to the spring bolt. In order to assure perfect results in each case it is necessary to leave considerable stock in the bushings. This necessitates both a roughing and finishing operation, as the bushing when first pressed in is too small for a standard reamer to enter. The roughing reamer, with a long pilot, is used to remove most of the stock in the first operation. The expansion reamer can then be set to the exact size desired and the bushing reamed to give the proper clearance.

Satisfactory results are obtained by this method and we recommend CO-200 Spring and Shackle Bolt Bushing Reamers to you as a valuable, time-saving addition to your Special Tool equipment.

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WATCH THE GREEN SHEETS EXTENDING BELOW FOR REVISIO
1C 2C 3C 4C 5C 6C 7C

REAR AXLE

1-C—Axle Housing Sprung

The rear axle housing is made sufficiently strong to eliminate chances of becoming sprung. However, if the wheels receive an exceptionally heavy blow by skidding into the curb or dropping in a hole on the road, the housing may become sprung.

Extreme care should be used in straightening an axle housing. If only slightly sprung, it may be cold straightened in a heavy press. *Heat should never be used* and if badly sprung the housing should be replaced with a new one.

2-C—Adjustment of Ring Gear, Pinion and Bearing

Conditions such as objectionable noise, excessive backlash between the gears, and play in the pinion, side play in the differential, and the axle having been partially or wholly disassembled are usually the reasons for making adjustments on gears and bearings. The adjustment should be made strictly in accordance with Operation Article No. 49.

3-C—Ring Gear and Pinion not Matched

Ring gears and pinions are matched at the factory and wired together in sets. When necessary to replace either ring gear or pinion, it is very essential that both be changed and a set of matched gears used in order to obtain a satisfactory adjustment.

4-C—Broken Rear Axle Parts

In case any of the rear axle parts have become broken, the differential must be completely disassembled and the axle housing and all disassembled parts thoroughly washed with kerosene or gasoline.

Inspect all parts carefully and replace those which have been damaged or sprung. This will eliminate the possibility of an unsatisfactory job when the axle is reassembled.

Also examine the rear axle housing to see if it is sprung or broken. See Diagnosis under "Tire Treads Worn," page 11.

In case of broken gears, examine the transmission line for excessive backlash. If the backlash is considerable, so that there is a strain on the rear axle parts when engaging the clutch, it should be remedied, otherwise the gears may break again.

DISC WHEELS

5-C—Mounting Hubs

The nuts holding the wheel to the hub are marked "R" and "L" indicating right and left. Care should be used in installing the hubs to see that the right and left nuts come on the corresponding side of the car.

After operating a car equipped with disc wheels for the first 50 or 75 miles, the wheels are worked in and the nuts holding the wheels to the hubs should be tightened. No further adjustment is then necessary.

6-C—Mounting Wheels

To mount the wheels, pass the pilot end of the disc wheel socket wrench through the stud hole in the disc and over the lowest stud of the hub, the weight of the wheel keeping the hub from turning. Next lift the wheel, and with the foot guiding the lower part and the hand supporting the upper, slide the wheel into place. Before removing the foot screw on one or two nuts by hand. Then screw on the other nuts and draw them tight with the wrench.

UNIVERSAL JOINTS

7-C—Lubrication of Spicer Universal Joints

A very large percentage of difficulty experienced with universal joints is due to lack of proper lubrication; not necessarily to an insufficient quantity of grease, but to the use of an unsuitable lubricant or an excessive amount.

There is a certain amount of natural leakage of grease from joints which cannot be entirely eliminated. However, if some abnormal conditions are not causing excessive leakage, lubrication is only necessary about every 500 to 1000 miles. Any of the conditions mentioned in the diagnosis on page

15 may cause the grease to be thrown out in a very short time.

When the joints have been disassembled, it is essential that engine oil be applied to the bushings and cross when assembling. This is necessary to lubricate the joints until the grease with which they are packed works in.

8-C—Assembling Front Joint Yoke Sleeve to Shaft

Failure to properly assemble the sleeve on the shaft will cause a binding action between the front and rear joints, resulting in noise and heating of joints, which in turn will cause excessive leakage of grease.

The shaft and sleeve are marked with an arrow. When assembling, these marks should be opposite each other.

9-C—Propeller Shaft Sprung

Because of the sturdy construction of the propeller shaft, breaking or even springing is a very rare occurance.

Should the shaft become sprung, remove the assembly and straighten it cold if at all possible. If the shaft is too badly sprung to straighten cold, it should be replaced with a new one. However, in an extreme emergency case it may require straightening by heating. If the shaft is heated to straighten, it should be heated only to a cherry red and allowed to cool slowly.

Before heating, drill a $\frac{1}{8}$ inch hole in the shaft, which is tubular, to allow the gases to escape and prevent any possible injury by an explosion.

10-C—Lubrication of Mechanics Universal Joints

A Mechanics propeller shaft and universal joint assembly is now being used in Big Six 127 inch wheelbase cars starting with serial No. 2115661.

Grease should never be used in these joints. Two screw plugs are provided in each joint for the purpose of lubrication. Both plugs must be removed and the joint filled with a light transmission oil, the oil entering the one hole and the air escaping from the other. This insures filling the joint with lubricant and under normal circumstances refilling is necessary only once every six months provided there are no grease leaks in the joints.

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TOLERANCE CHART

THE CHART on the following page is for your convenience in repair work. It will give you definite information as to the serviceability of parts subject to wear and distortion.

Considerable judgment must be exercised in its use, however, and any decision based on this data must be tempered by individual conditions and the wishes of the car owner.

For example, the maximum clearance between the steering worm gear shaft and its bushing is given as .008 inch. This means that, when overhauling the steering gear to put the assembly in first class condition, parts having clearance up to this amount may be considered serviceable, while those with greater clearance must be replaced to obtain a first class job. However, this is not to be interpreted as meaning that a worm gear shaft with greater clearance is totally unfit for service. The thoroughness of overhaul as specified by the owner should determine this.

	Tolerance For New Parts		Tolerance For Parts In Service
	MIN.	MAX.	MAX.
Front Wheels			
Toe-in			
Balloon tires	1/16"	1/8"	1/8"
High Pressure tire	1/4"	3/8"	3/8"
Front Wheels			
Camber	3/4"	1 1/4"	1 1/4"
Front and Rear Wheels			
Run out (measured at wheel felloe)	0	1/8"	1/8"
Steering Knuckle Pin *(All Models)*			
Roundness	—	—	.006"
Alignment	—	—	.002"
Clearance in bushing	—	—	.008"
Cross Tube Bolt (2-*Wheel brake equipment*)			
Clearance in bushing	—	—	.010"
Steering Gear			
Backlash (at steering wheel)	3/4"	1 1/2"	2 1/2"
Steering Gear Worm Gear Shaft			
Roundness	—	—	.004"
Alignment	—	—	.002"
Clearance in bushing	.0005"	.0025"	.006"
Spring Bolt			
Roundness	—	—	.010"
Clearance in bushing	.001"	.004"	.018"
Rear Axle Gears			
Ring gear and pinion backlash	.005"	.008"	.015"
Rear Axle Pinion			
Alignment	—	—	.0015"
Differential Case			
Alignment (amount of run out when mounted in differential carrier).	—	—	.002"
Differential Cross			
Roundness		—	.004"
Clearance in gear	.002"	.005"	.008"
Rear Axle Shaft			
Alignment	—	—	.003"
Backlash between axle shaft and differential side bevel gear	.002"	.008"	*.012"

*** Backlash of .012" may not in itself be objectionable. However, consideration should be paid to the rest of the transmission line, so that the total backlash does not become too great.**

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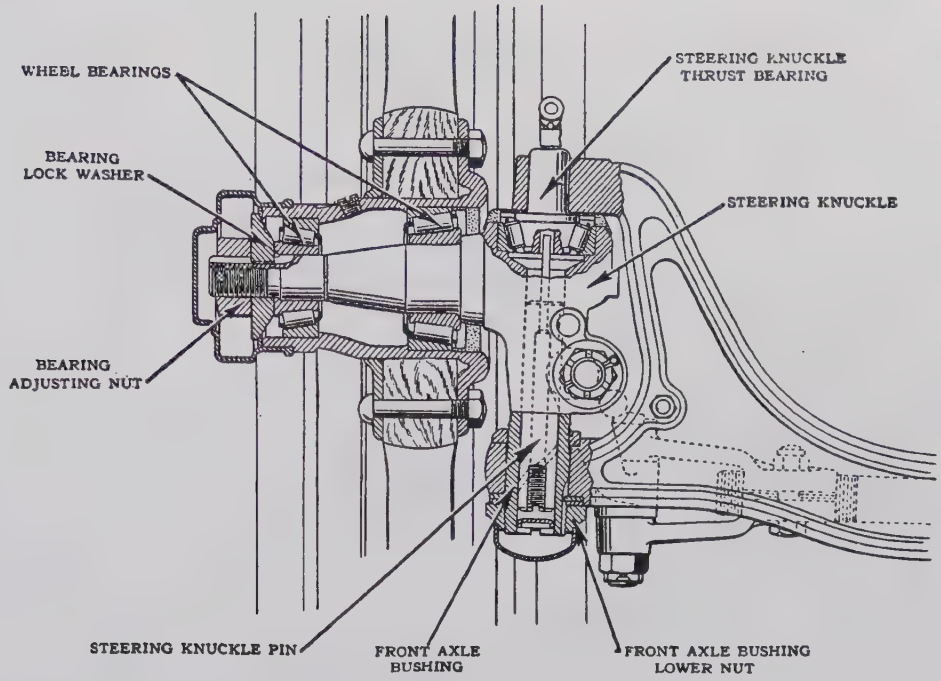
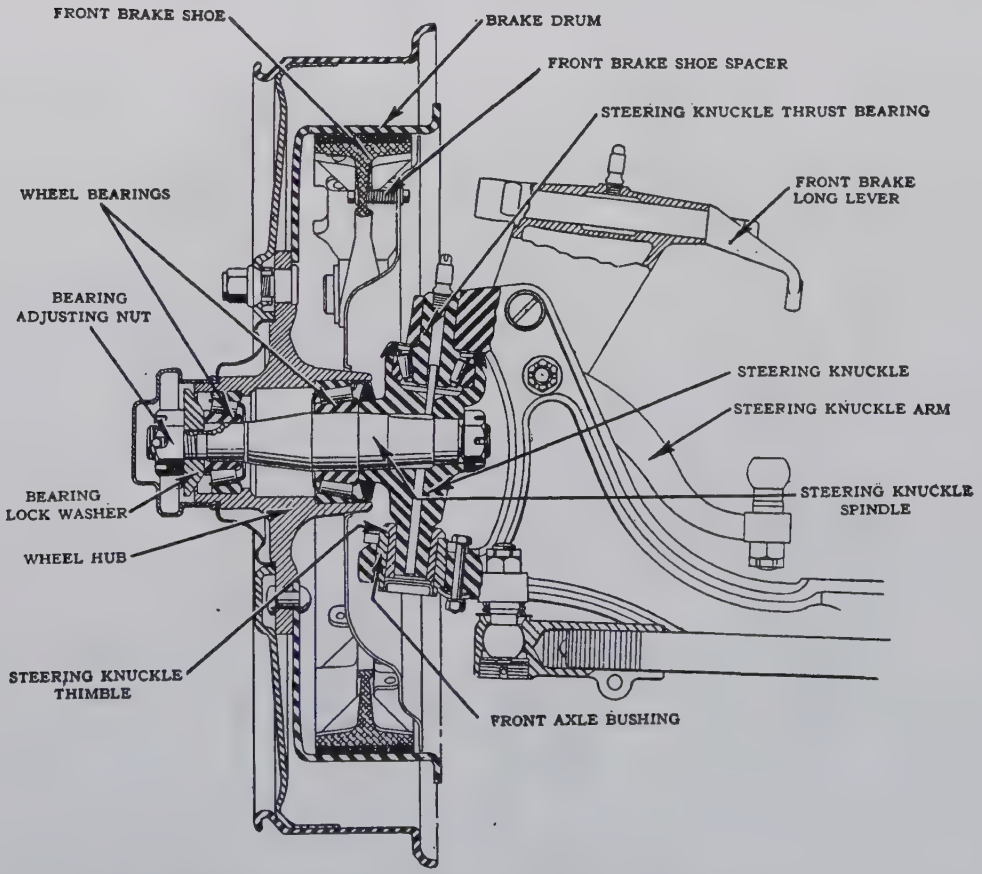
	Tolerance For New Parts		Tolerance For Parts In Service
Universal Joints *(Spicer Joints)*			
Bushing Clearance	.002"	.004"	.006"
Roundness of cross	——	——	.003"
(Mechanics Joints)			
Collar Clearance	——	——	.005"
Roundness of pins	——	——	.003"
Propellor Shaft			
Backlash in splines (Spicer)	.003"	.005"	.010"
Backlash in splines (Mechanics)	——	——	.010"

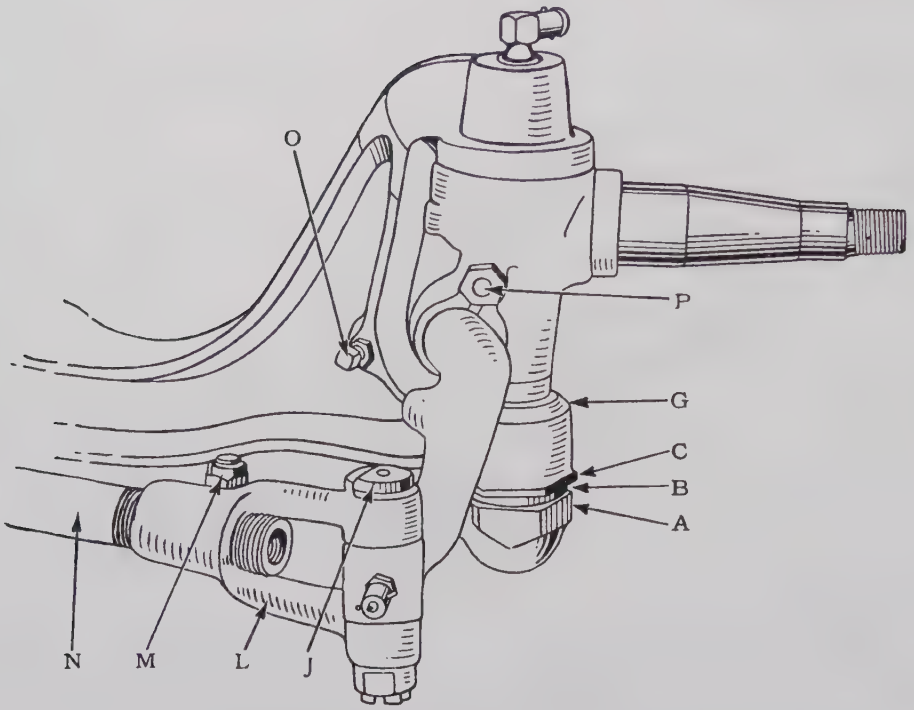
ILLUSTRATIONS



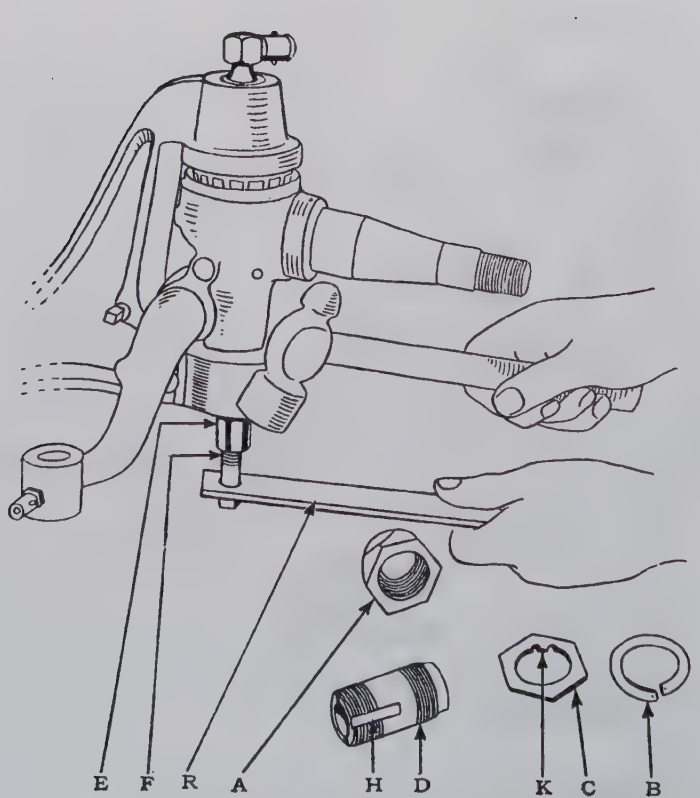
Illus. No. 1
Section Through Steering Knuckle (2-Wheel Brakes)



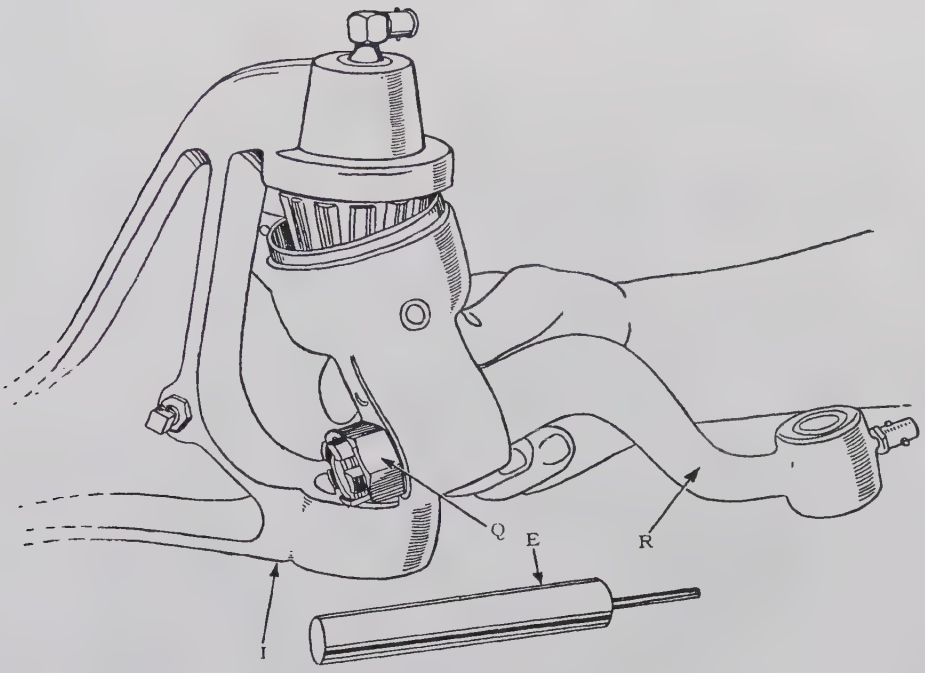
Illus. No. 2
Section Through Steering Knuckle (4-Wheel Brakes)



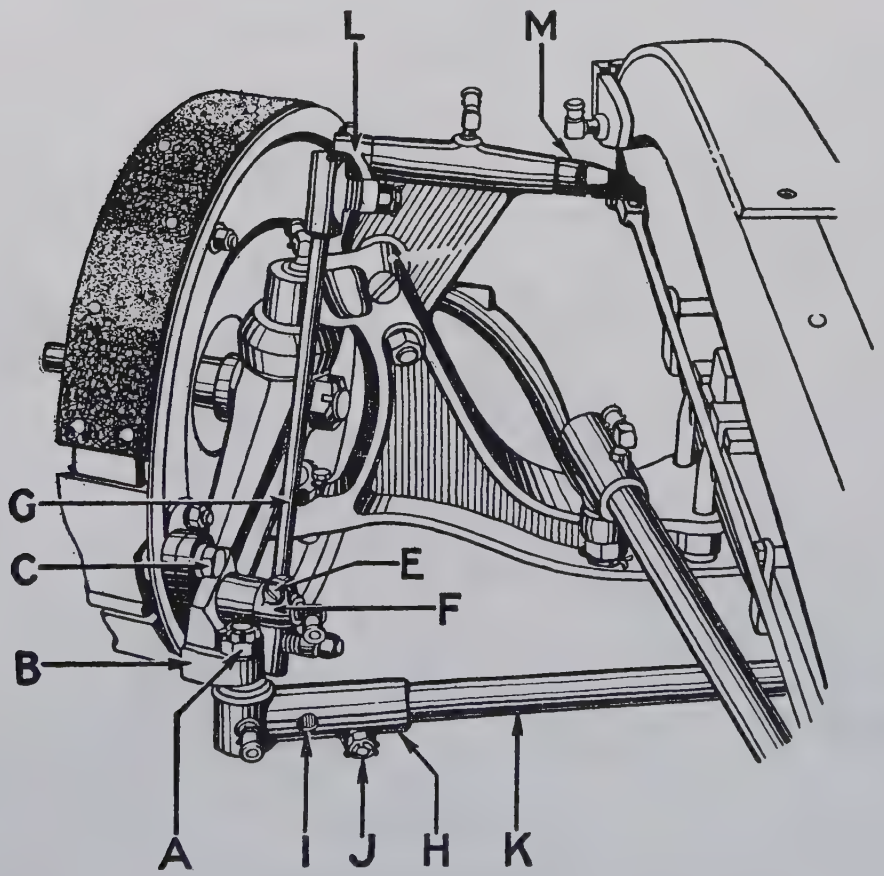
Illus. No. 3
Right End of Front Axle Assembly for Left-Hand Control
(2-Wheel Brakes)



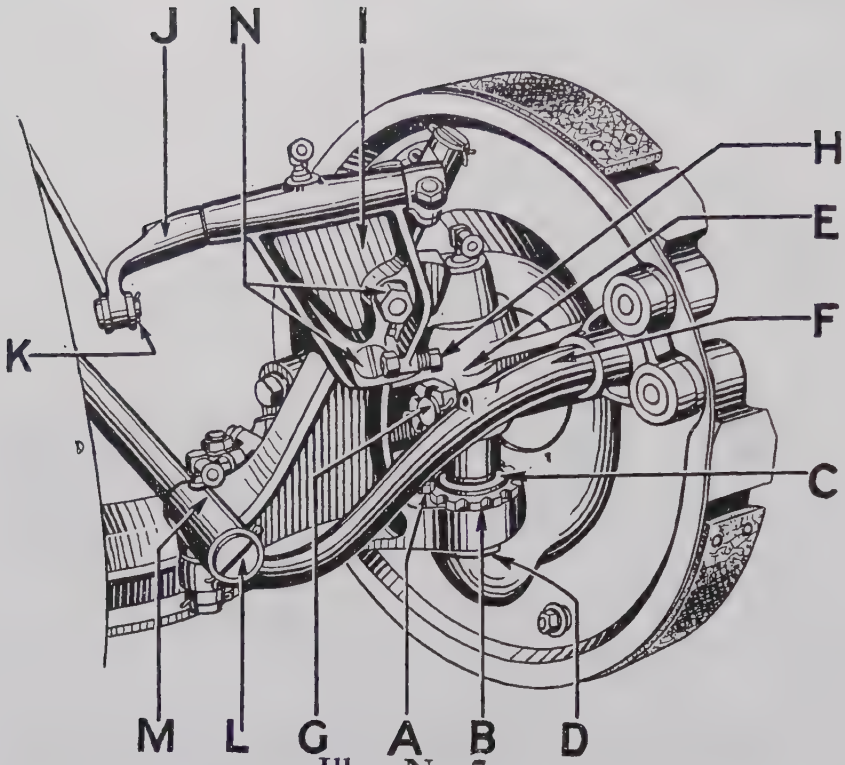
Illus. No. 4
Removing Steering Knuckle Pin
(2-Wheel Brakes)



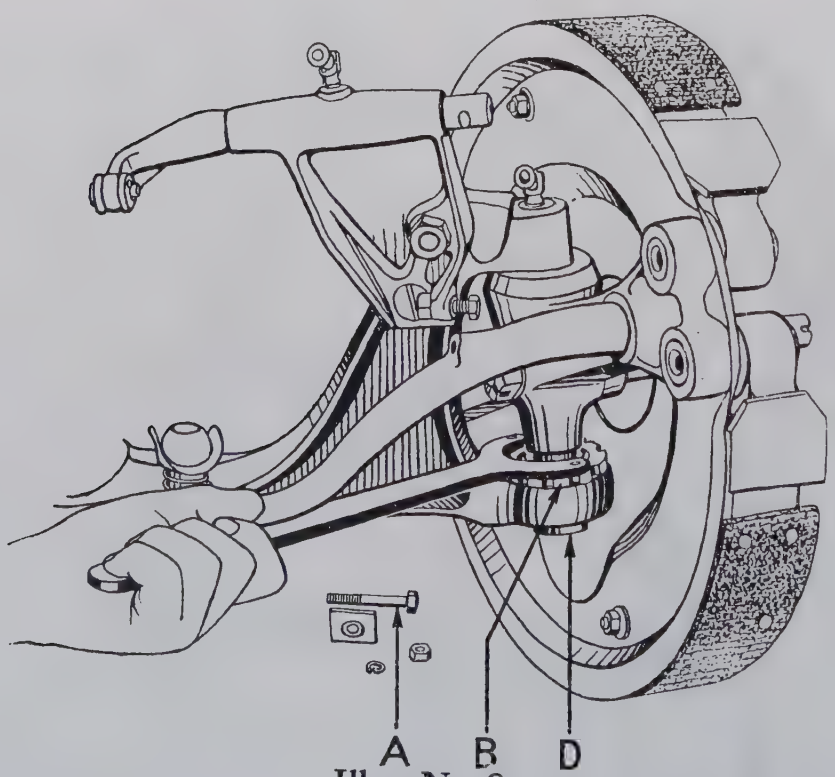
Illus. No. 5
Removing Steering Knuckle (2-Wheel Brakes)



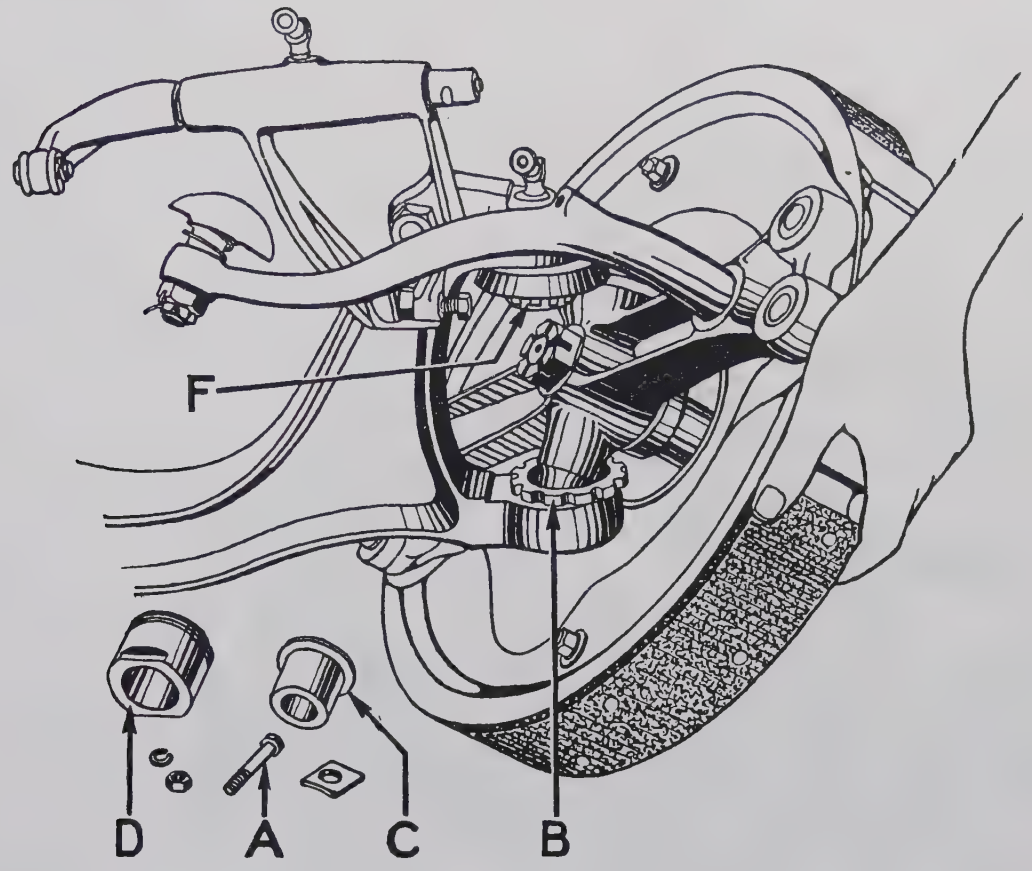
Illus. No. 6
Rear View of Left-Hand End of Front Axle (4-Wheel Brakes)



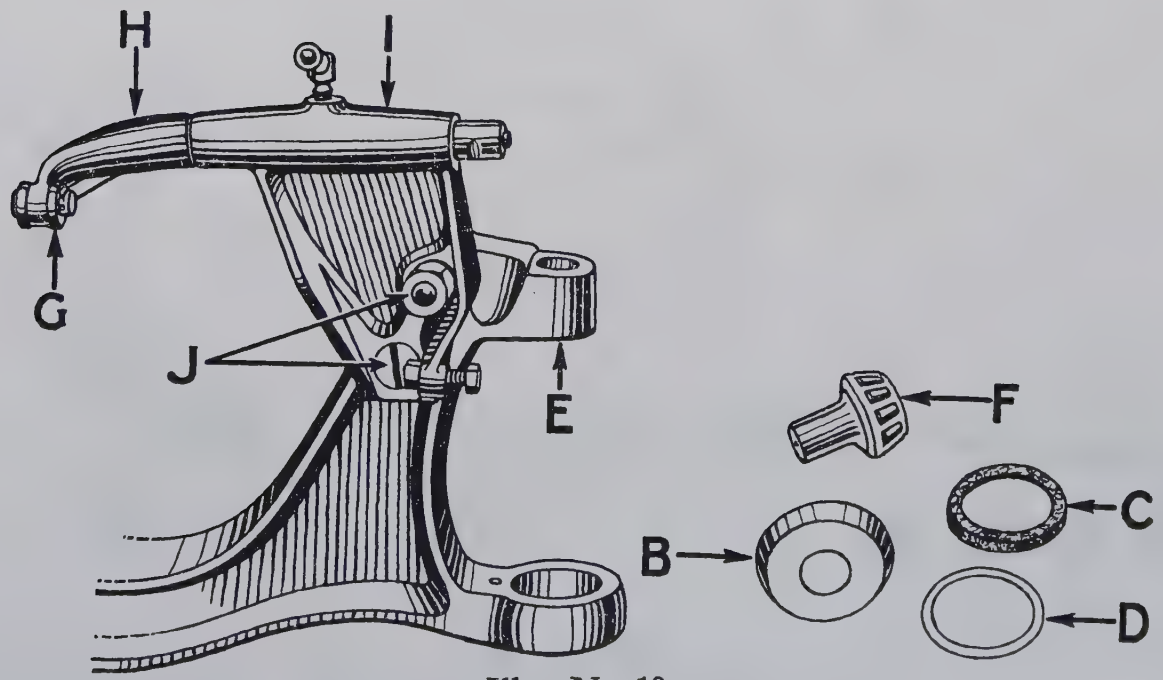
Illus. No. 7
Front View of Left-Hand End of Front Axle
(4-Wheel Brakes)



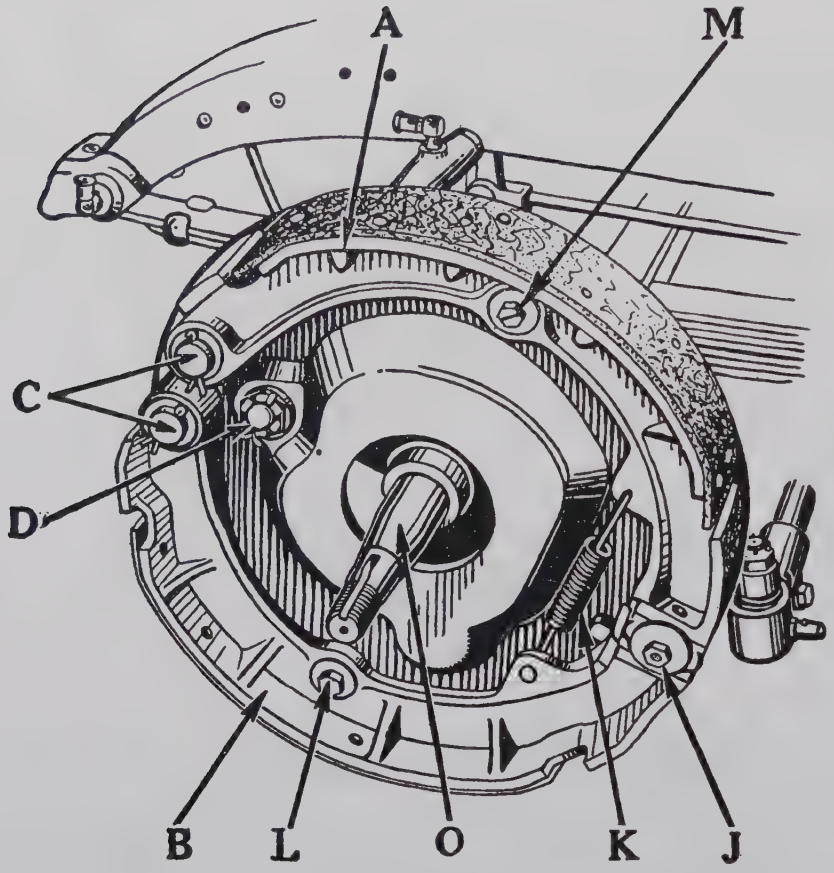
Illus. No. 8
Unscrewing Front Axle Bushing Upper Nut
(4-Wheel Brakes)



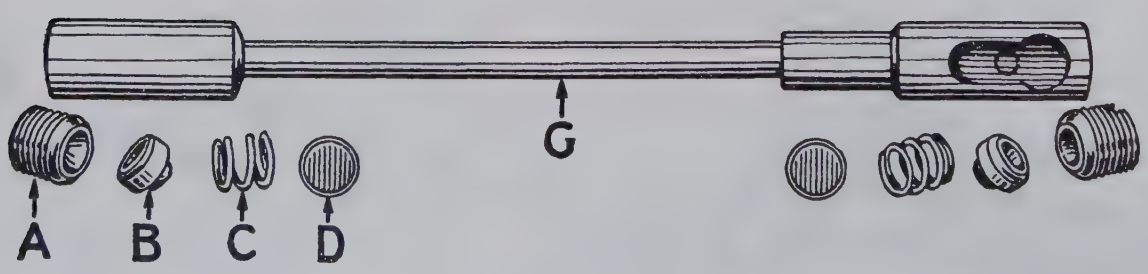
Illus. No. 9
Removing Steering Knuckle (4-Wheel Brakes)



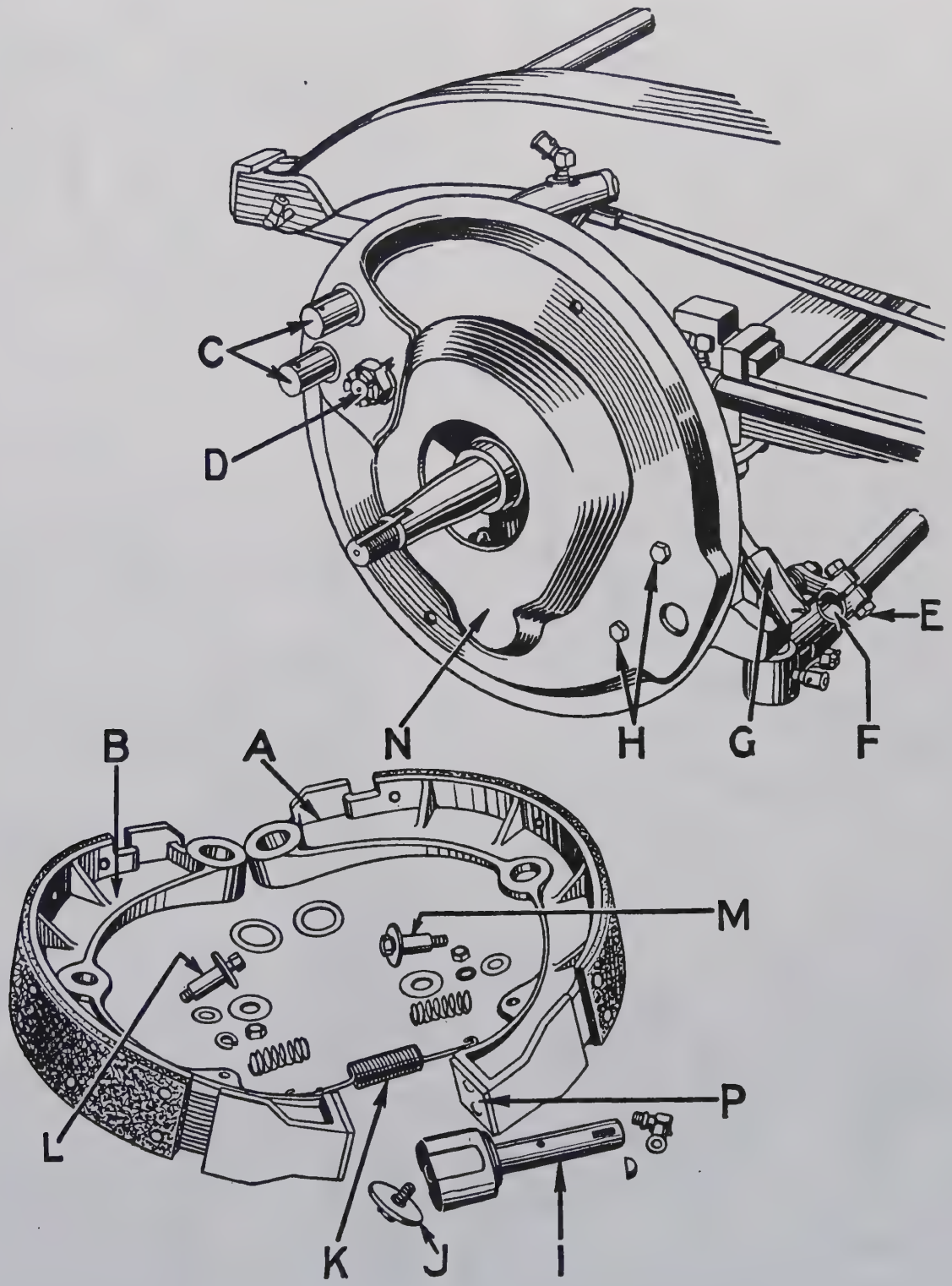
Illus. No. 10
Front Axle With Steering Knuckle Thrust Bearing Removed (4-Wheel Brakes)



Illus. No. 11
Front-Wheel Brakes

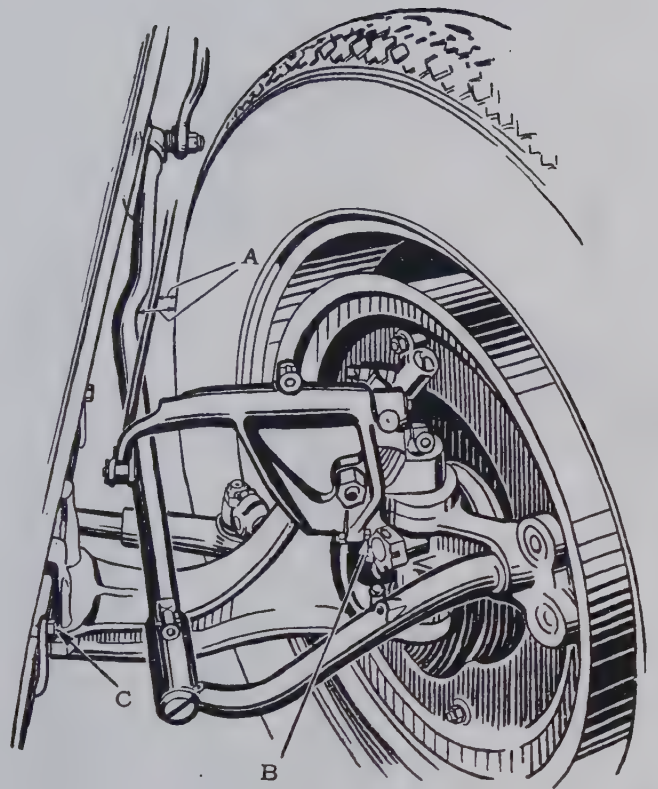


Illus. No. 12
Front Brake Connecting Link

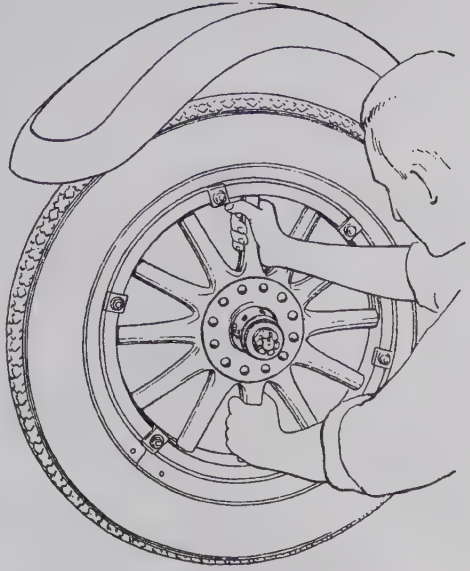


Illus. No. 13

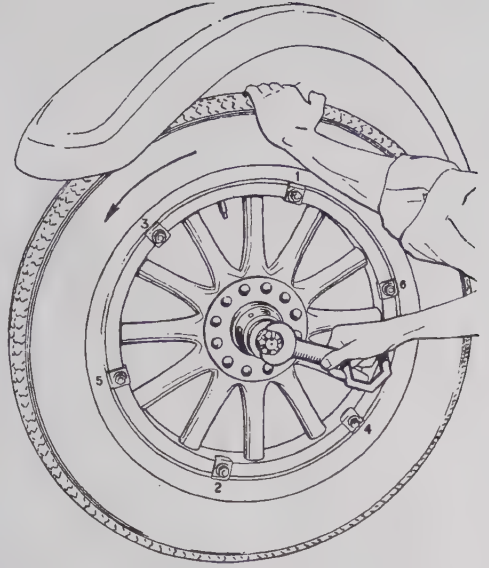
Front Wheel Brake Shoes Disassembled



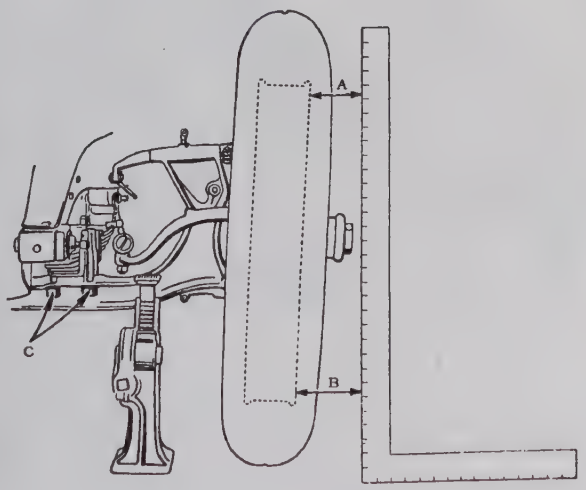
Illus. No. 14
Showing Clearance Necessary When Adjusting Turning Radius



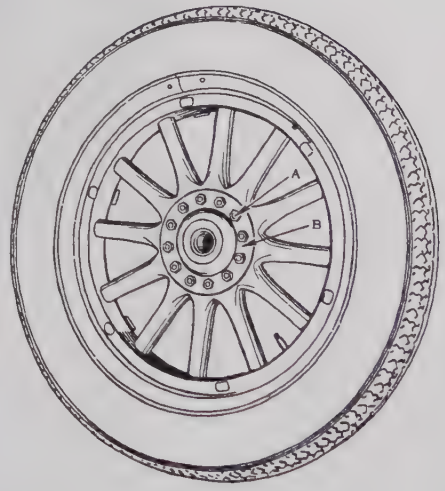
Illus. No. 15
Testing Front Wheel Bearing Adjustment



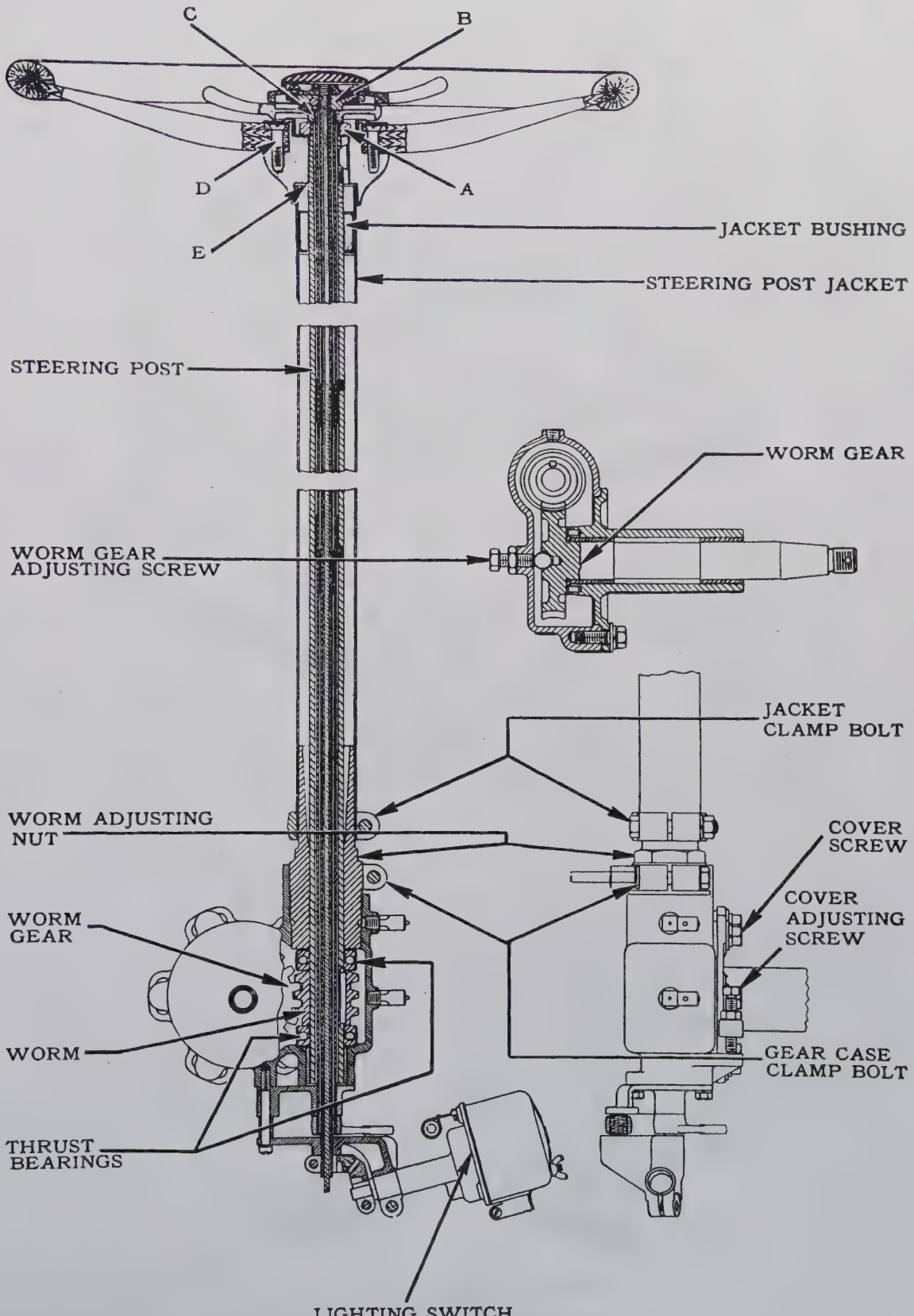
Illus. No. 16
Adjusting Front Wheel Bearings



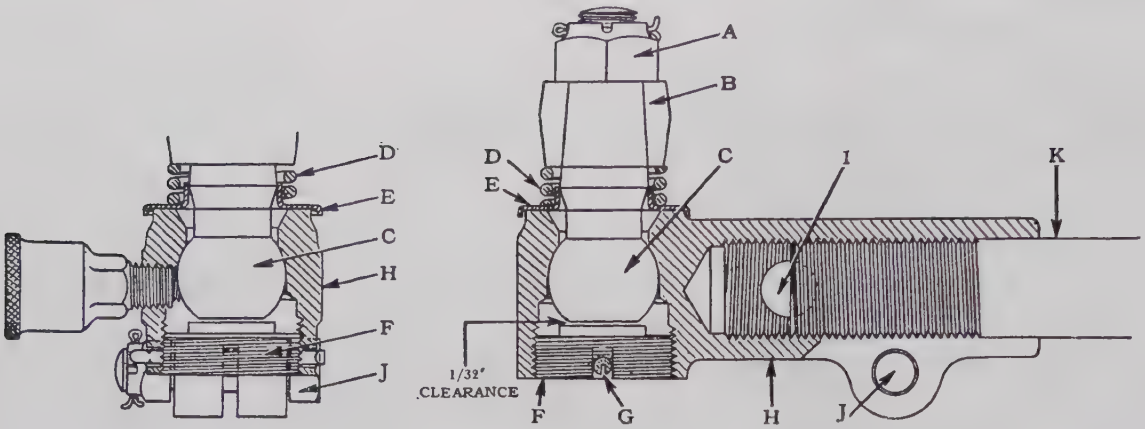
Illus. No. 17
Checking Wheel Camber



Illus. No. 18
Front Wheel Showing Hub Bolts

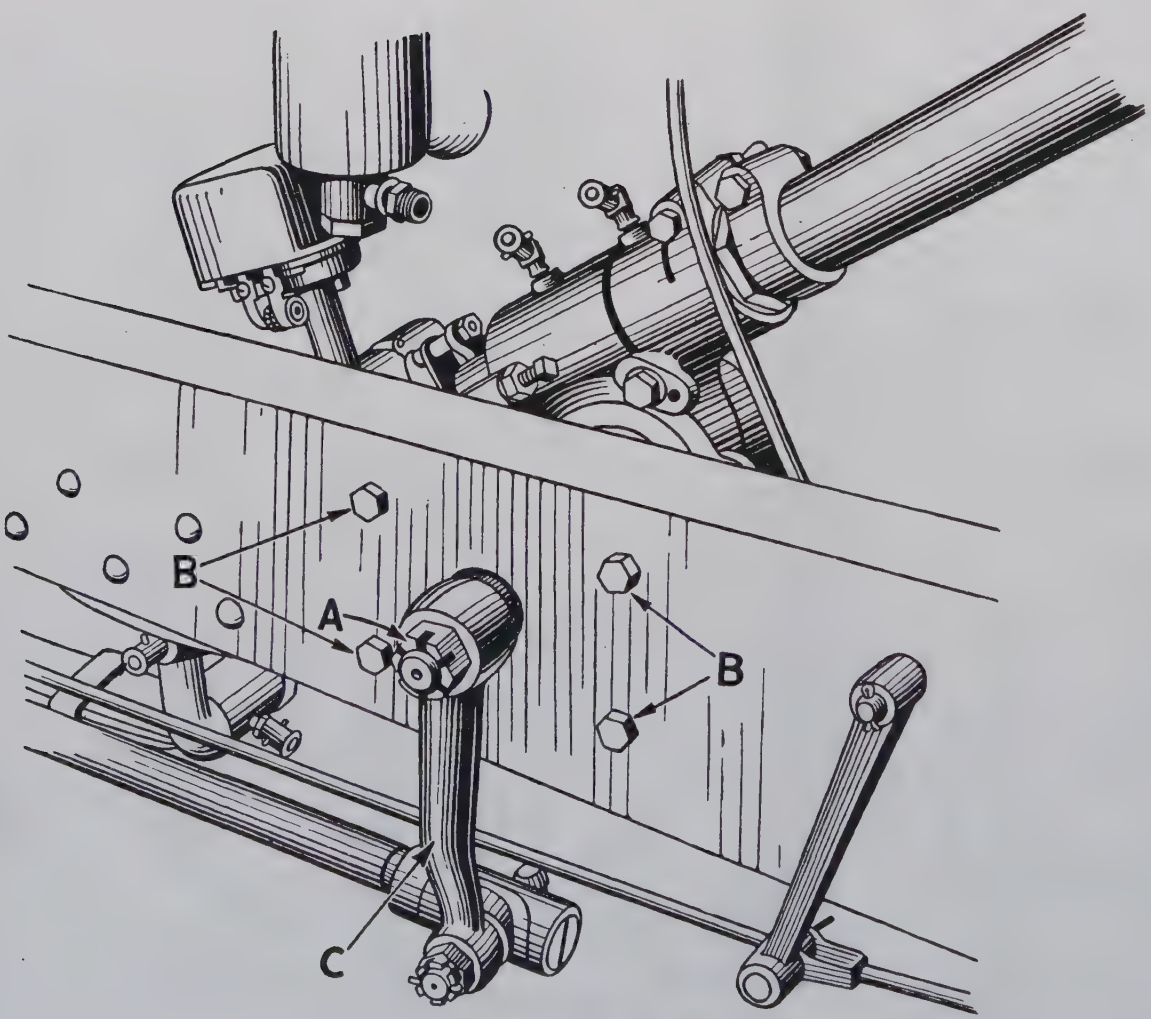


Illus. No. 19 Steering Gear Assembly



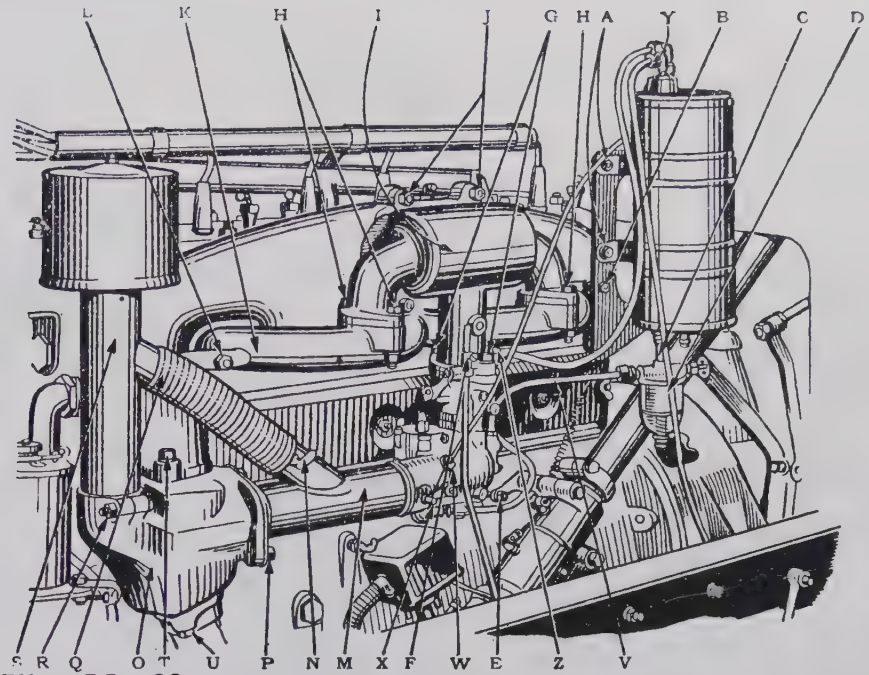
Illus. No. 20

Steering Cross Tube Assembly
(4-Wheel Brakes)

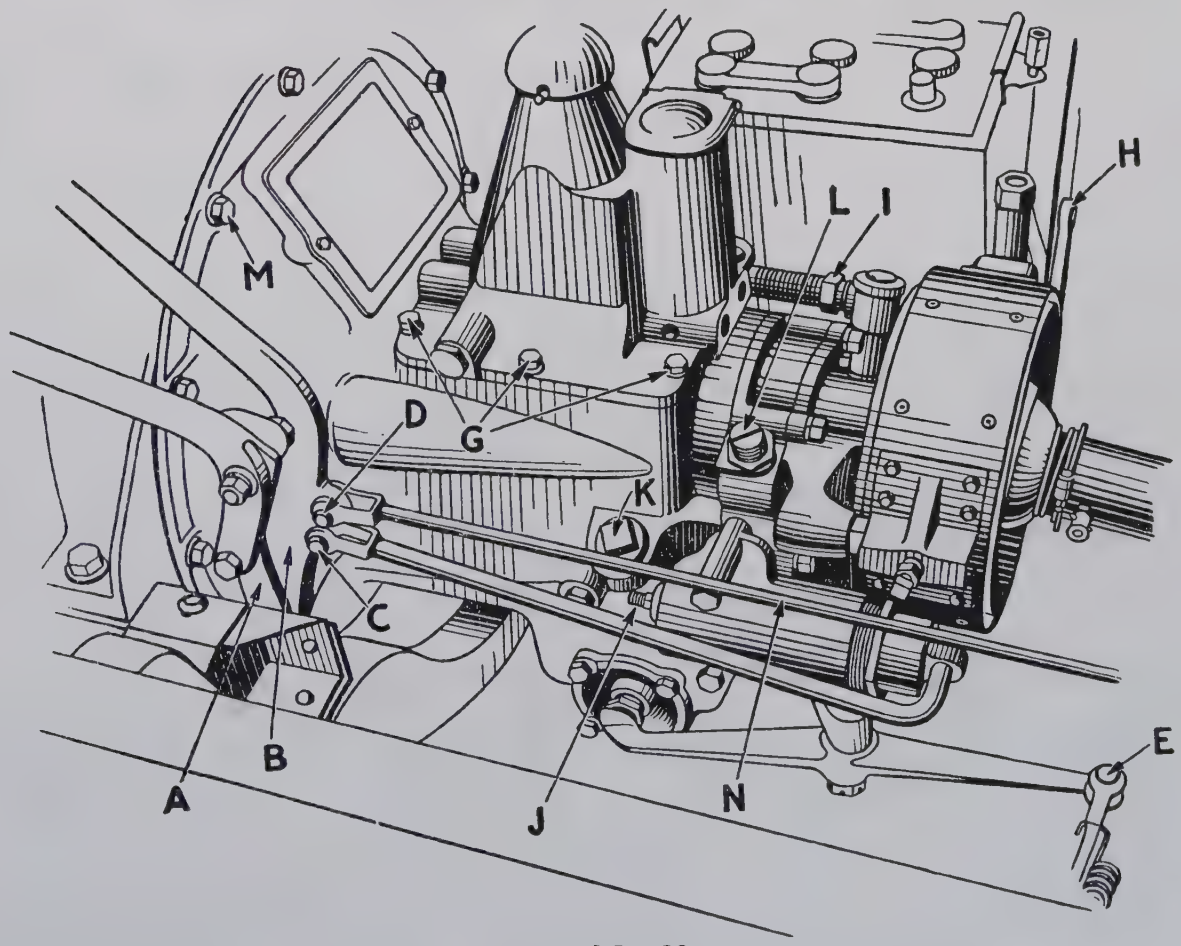


Illus. No. 21

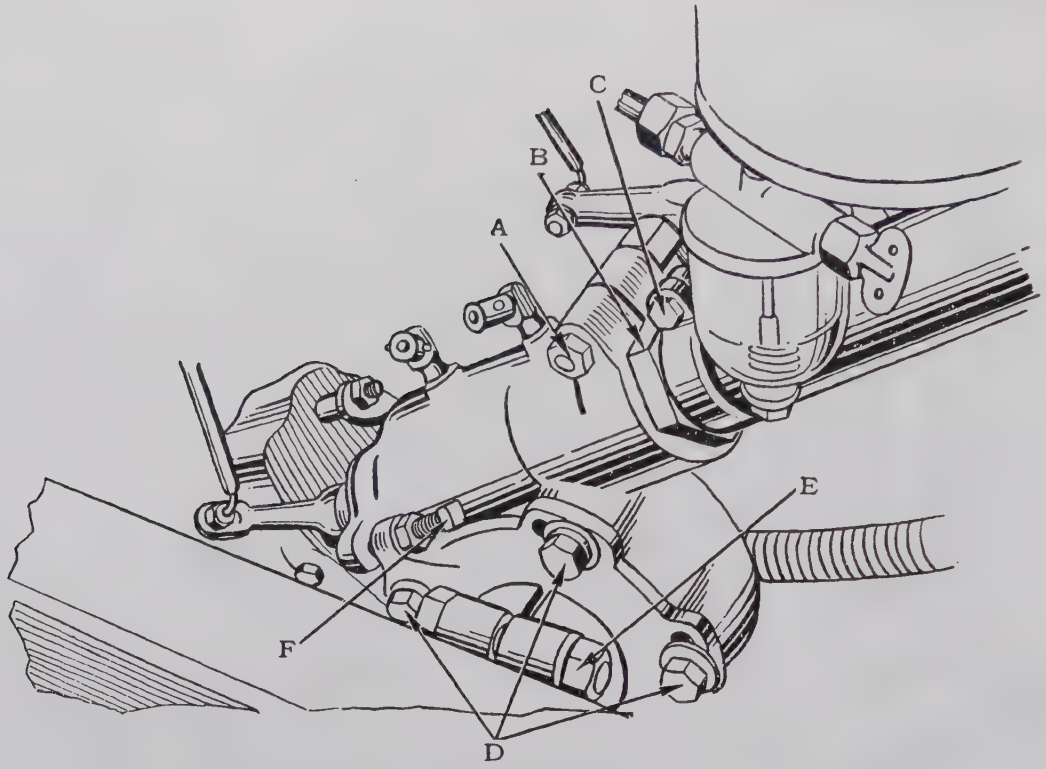
Steering Mechanism



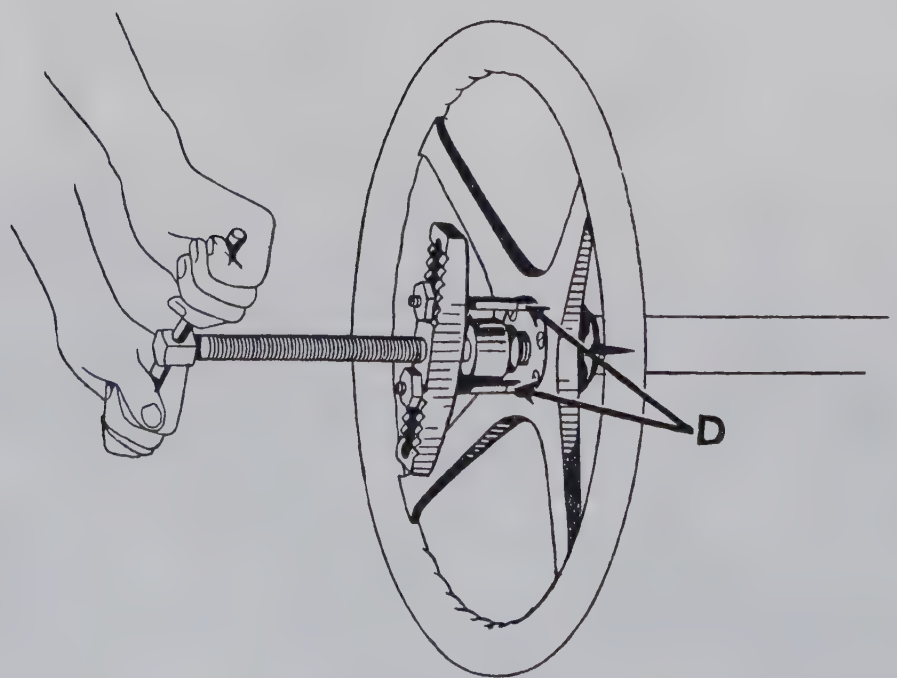
Illus. No. 22 Manifolds, Vacuum Tank and Carburetor Assembly



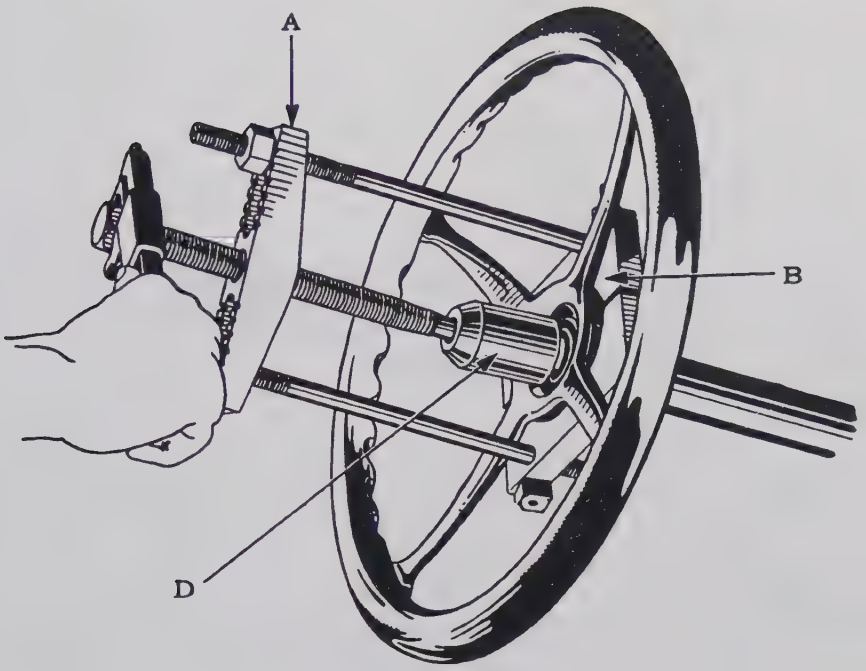
Illus. No. 23
Left-hand Side of Transmission Assembled in Chassis (Hydraulic Brakes)



Illus. No. 24
Steering Gear Adjustments

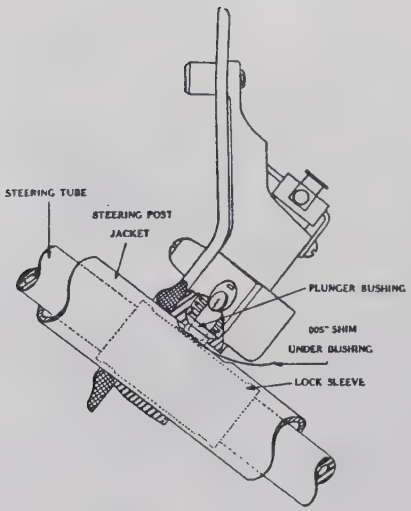


Illus. No. 25
Pulling Wood Steering Wheel



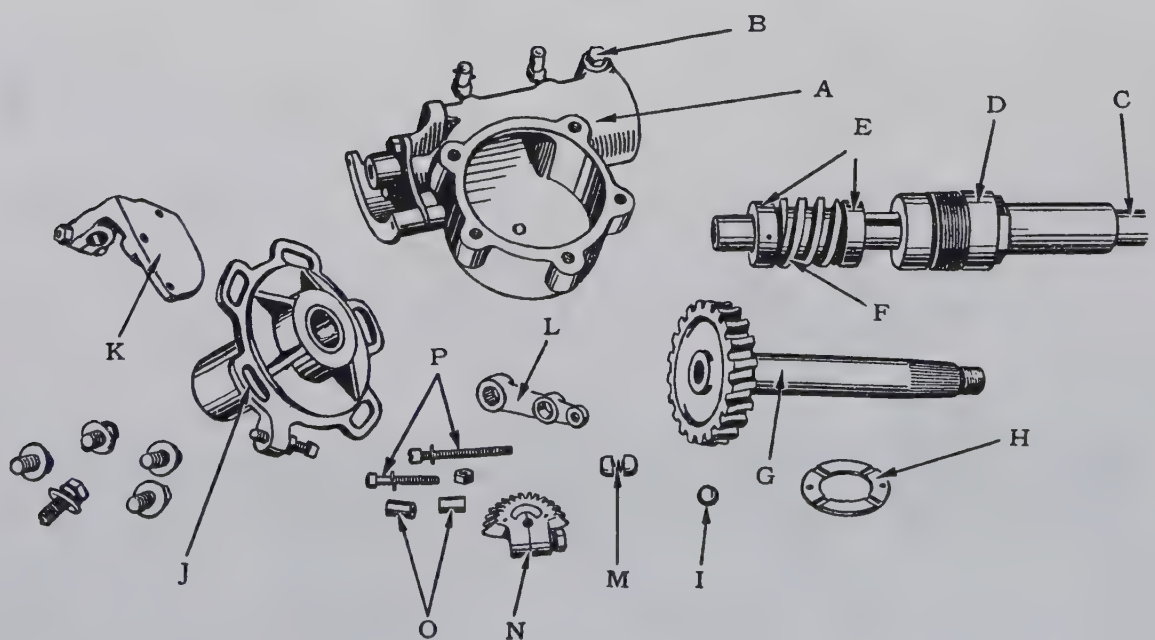
Illus. No. 26

Pulling Metal Spoke Steering Wheel



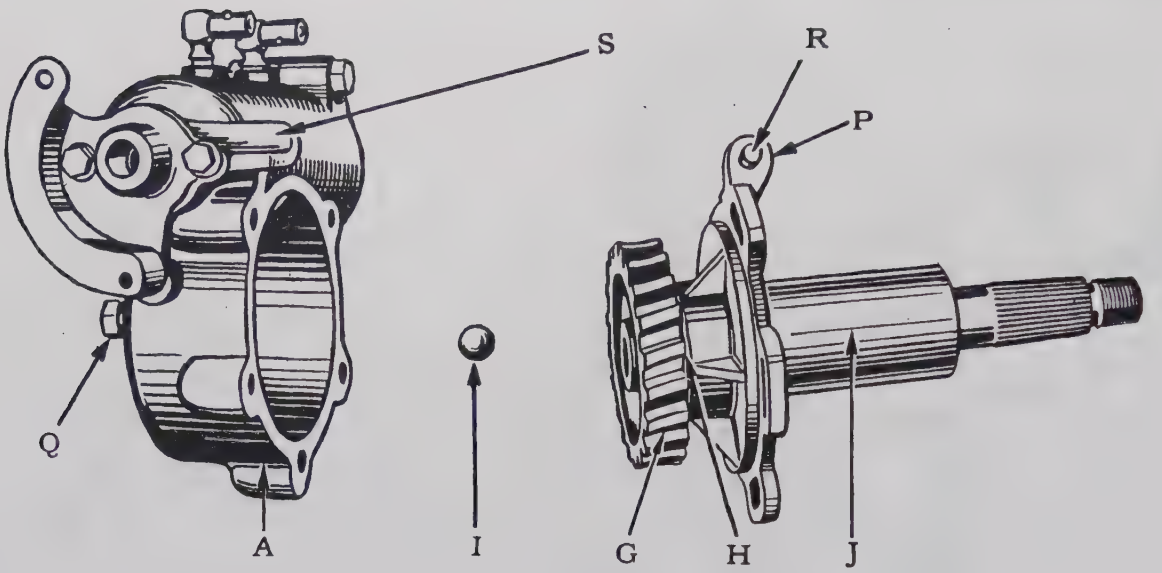
Illus. No. 27

Sectional View of Lock, Showing Shim in Place When Removing Lock

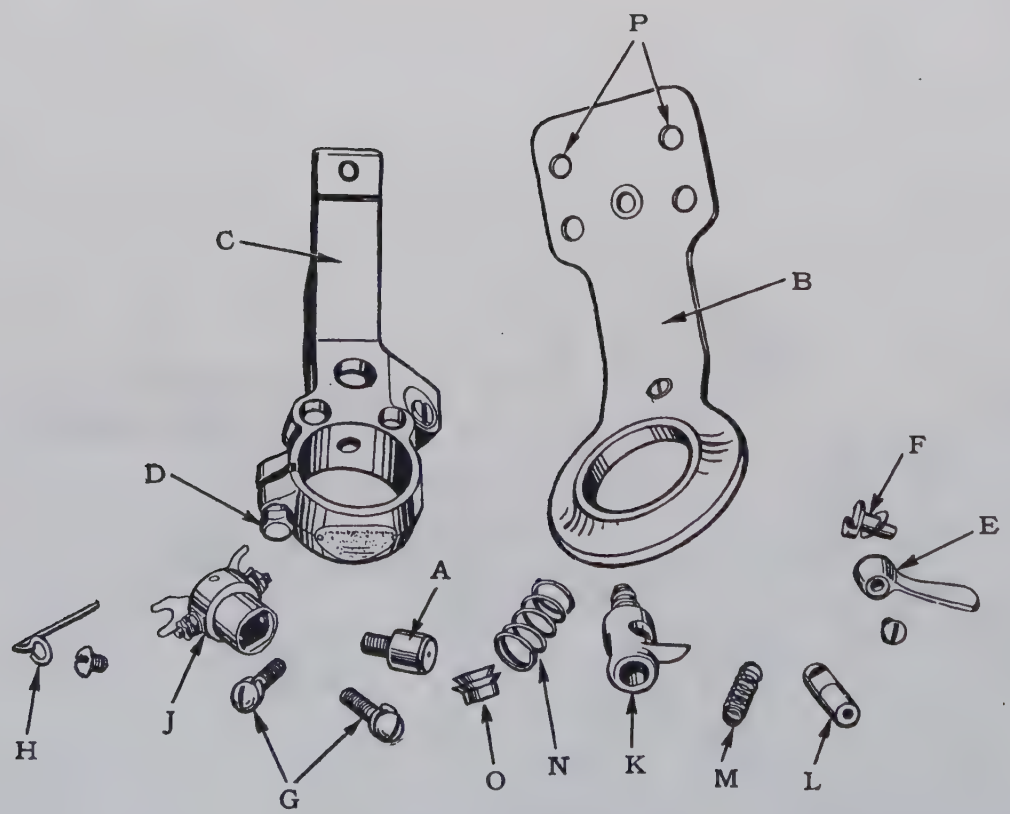


Illus. No. 28

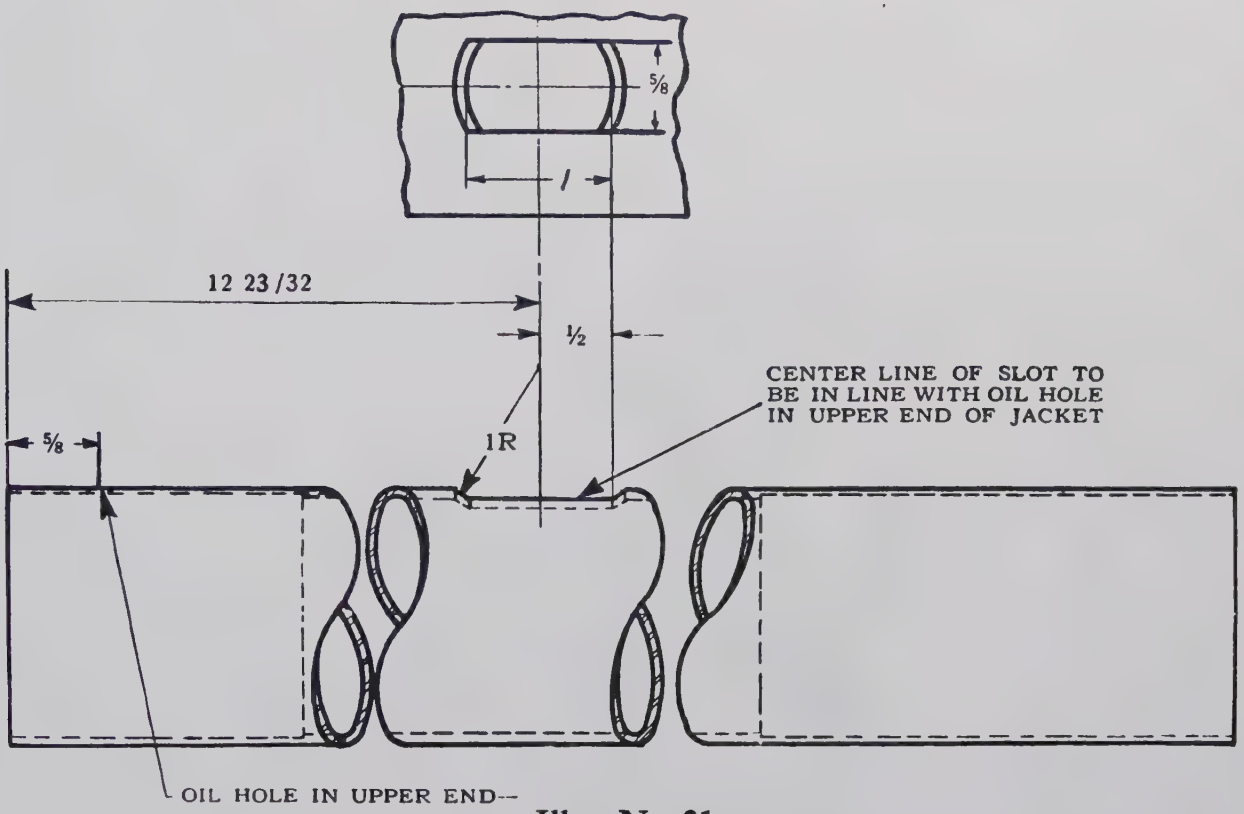
Steering Gear Disassembled



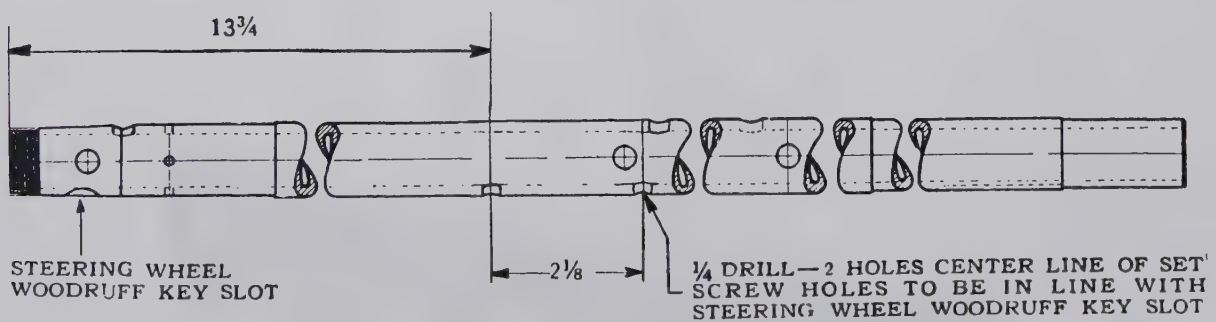
Illus. No. 29
Assembling Worm Gear and Cover



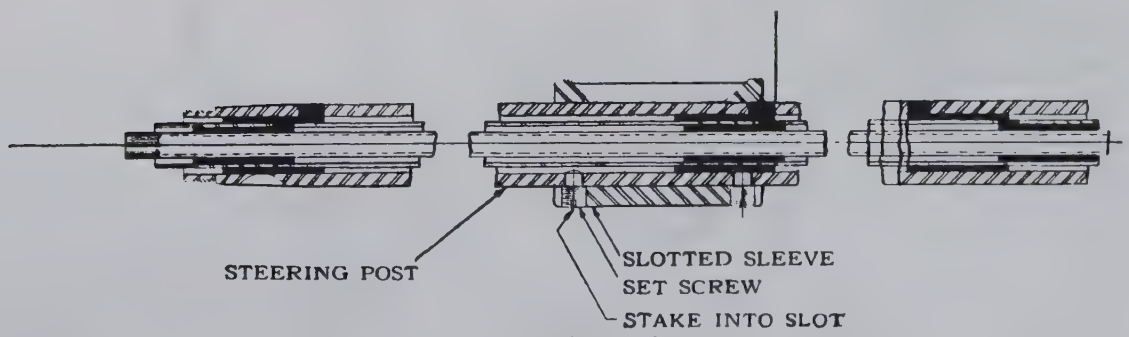
Illus. No. 30
Steering Gear Lock Disassembled



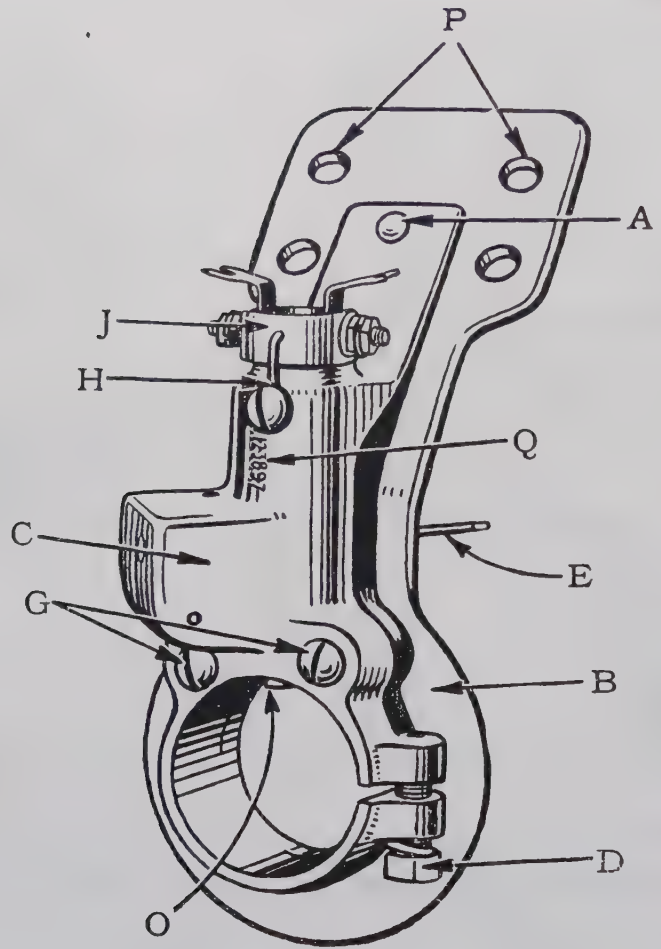
Illus. No. 31
Measurements for Cutting Slot in Steering Post Jacket


13¾
STEERING WHEEL WOODRUFF KEY SLOT
2⅛
¼ DRILL—2 HOLES CENTER LINE OF SET SCREW HOLES TO BE IN LINE WITH STEERING WHEEL WOODRUFF KEY SLOT

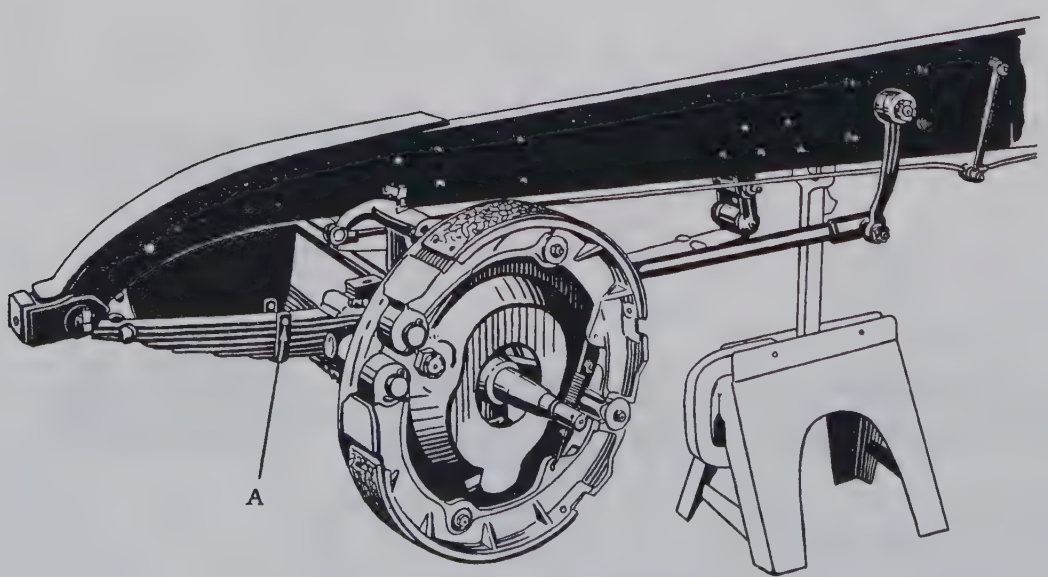
Illus. No. 32
Measurements for Drilling Set Screw Holes in Steering Tube



Illus. No. 33
Showing Slotted Sleeve Assembled on Steering Tube



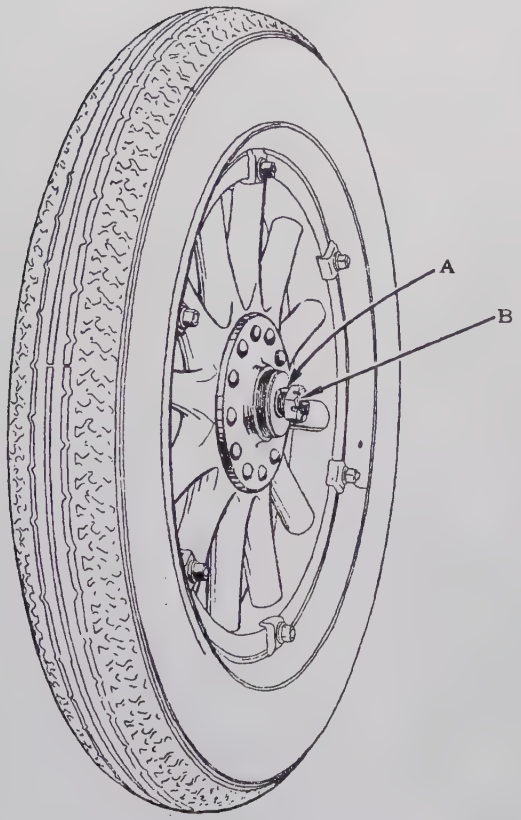
Illus. No. 34
Steering Gear Lock



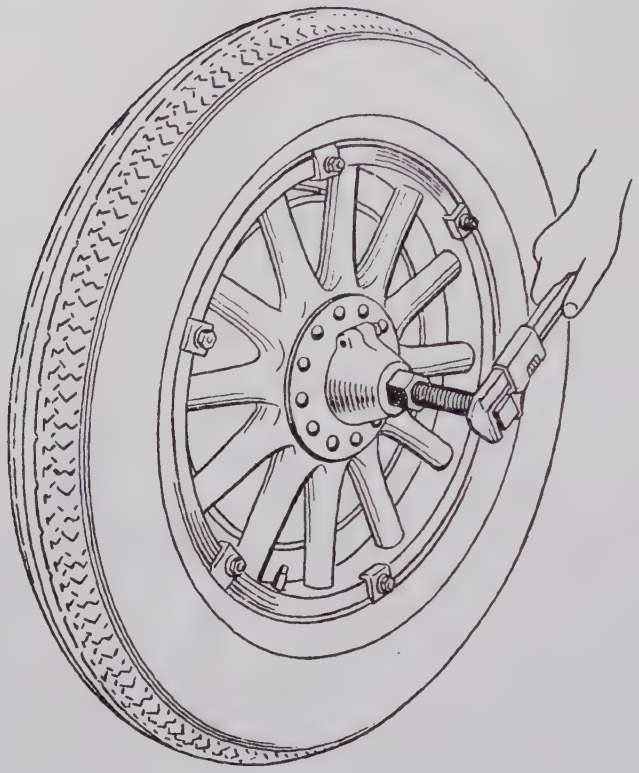
Illus. No. 35
Method of Blocking Under Frame

Illus. No. 36

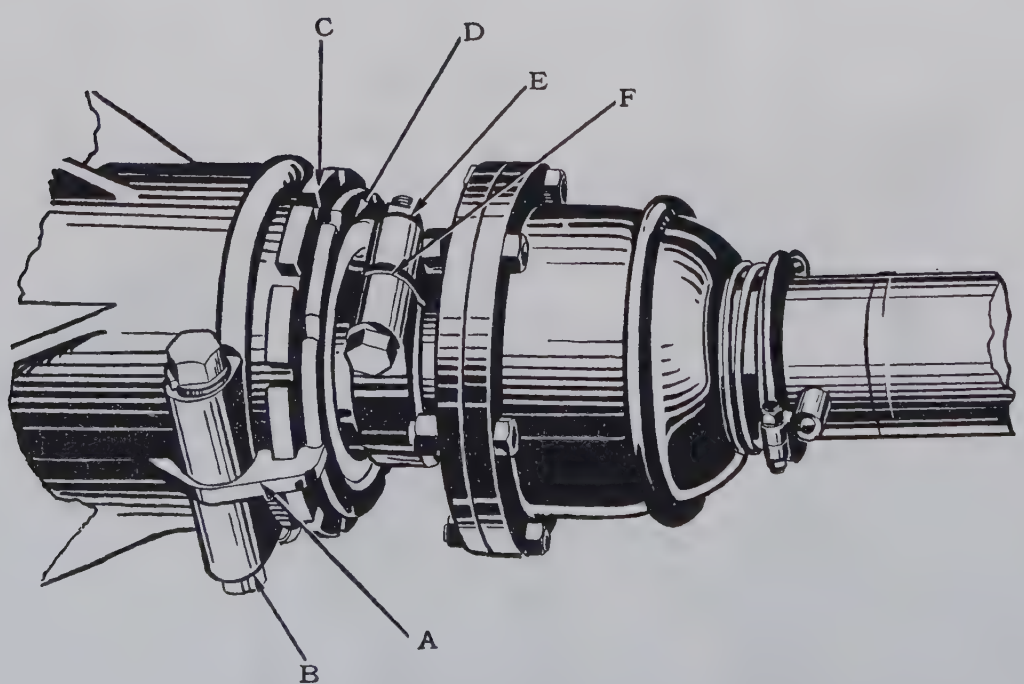
Longitudinal Section Through Rear Axle Assembly



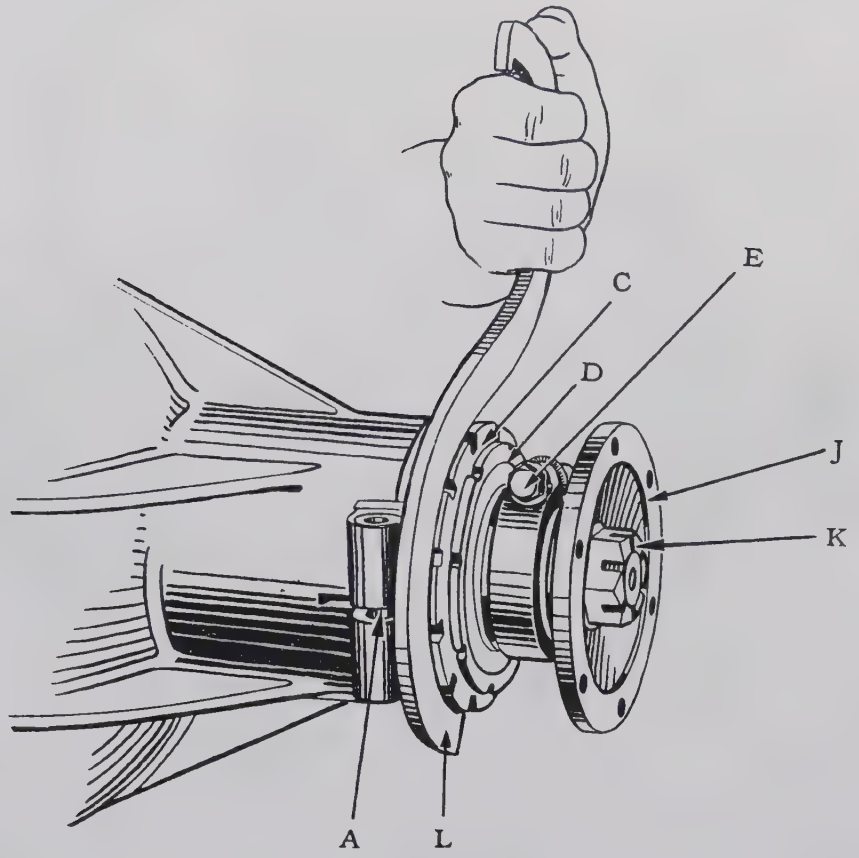
Illus. No. 37
Rear Axle Shaft Nut and Key



Illus. No. 38
Pulling Rear Wheel

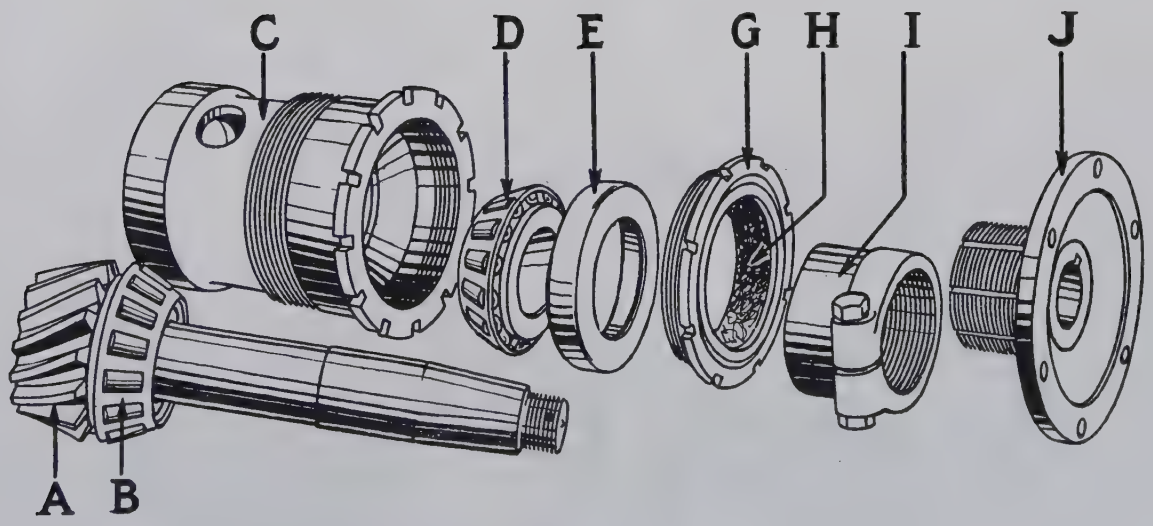


Illus. No. 39
Rear Axle Pinion Adjustment



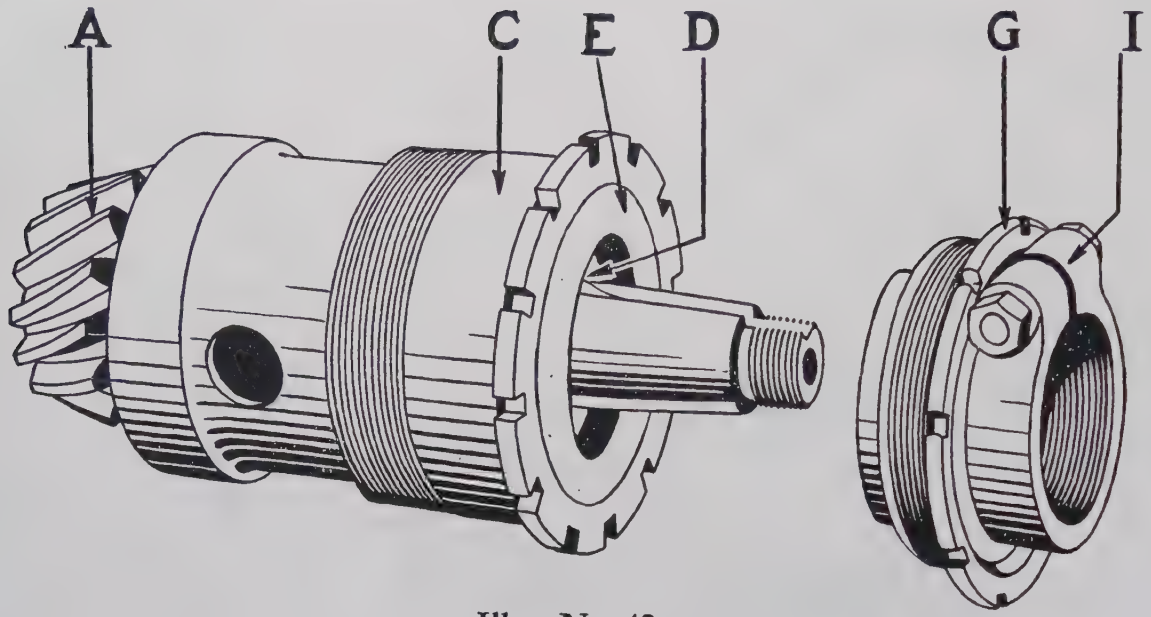
Illus. No. 40

Adjusting Rear Axle Pinion

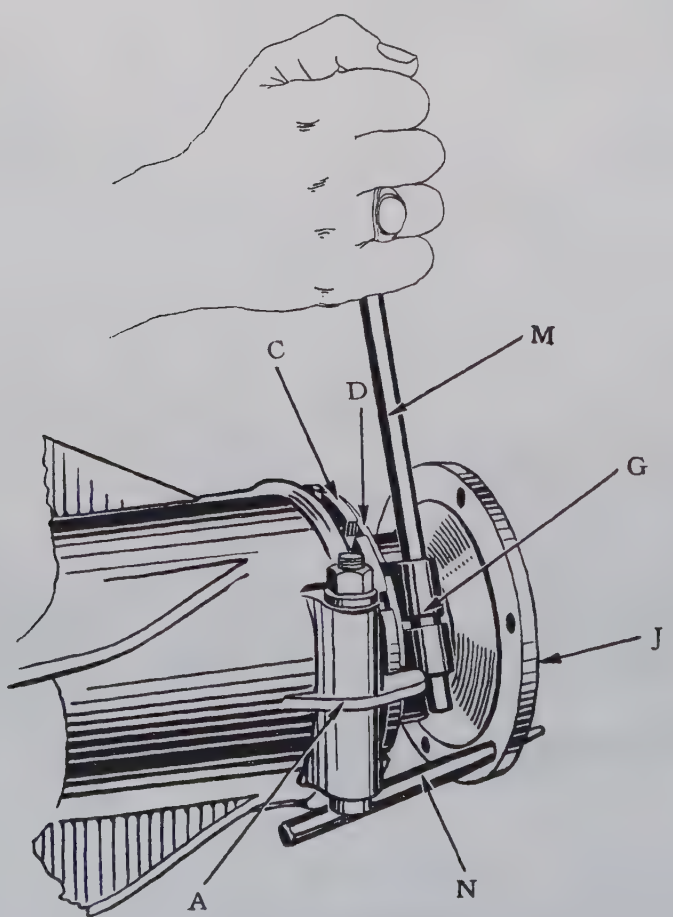


Illus. No. 41

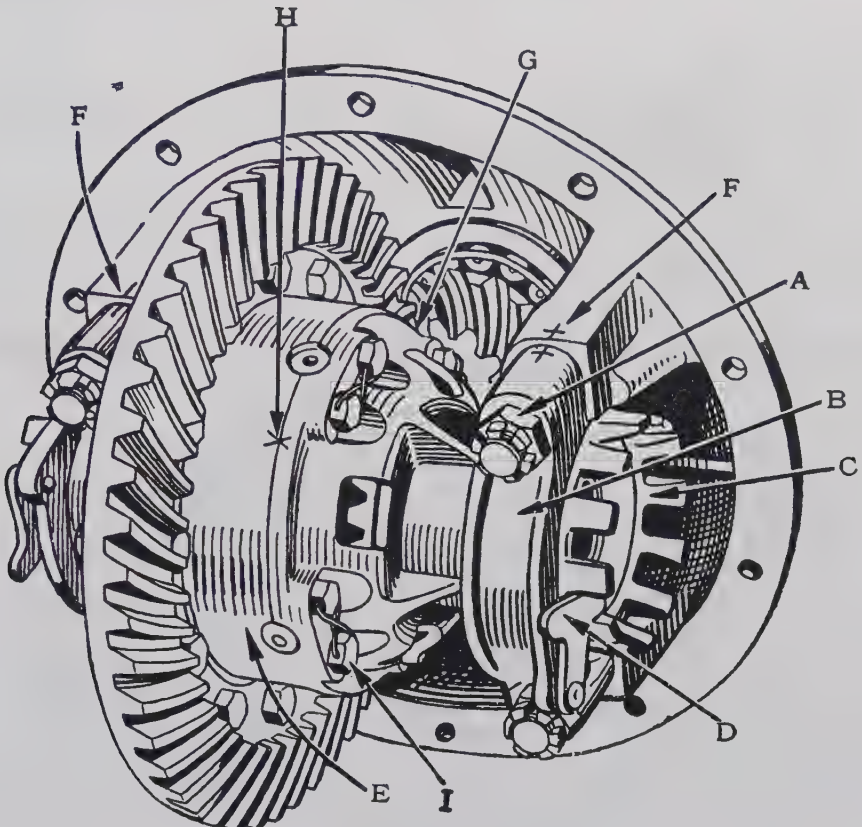
Rear Axle Pinion and Carrier—Disassembled



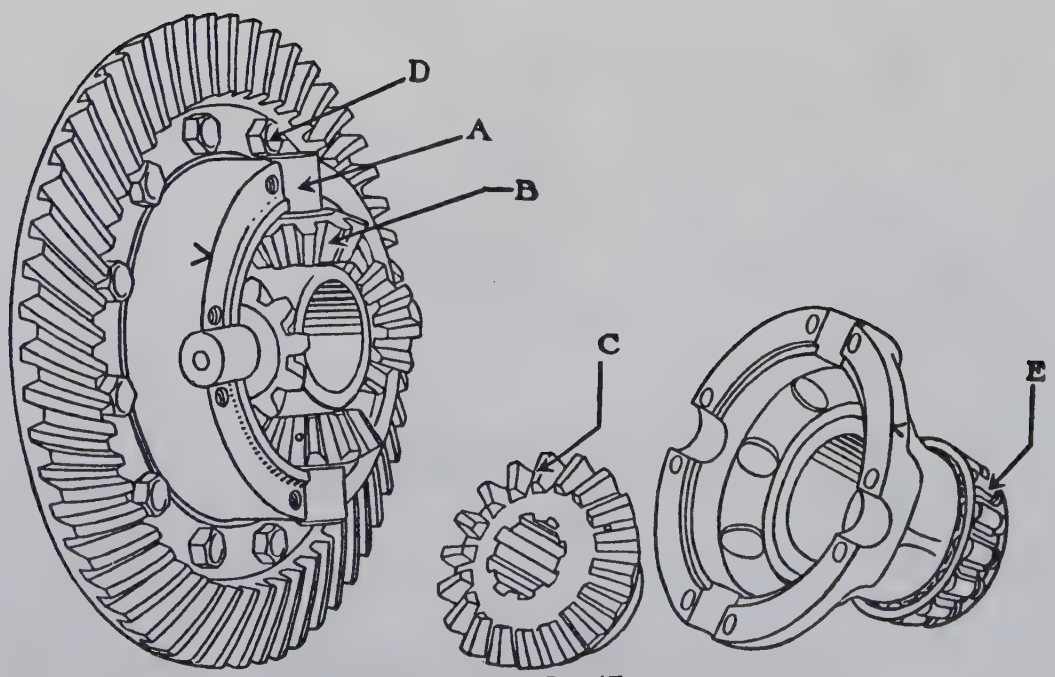
Illus. No. 42
Assembling Rear Axle Pinion and Carrier



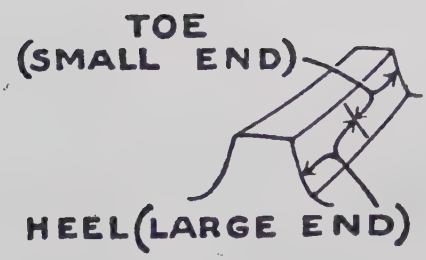
Illus. No. 43
Adjusting Rear Axle Pinion Bearings

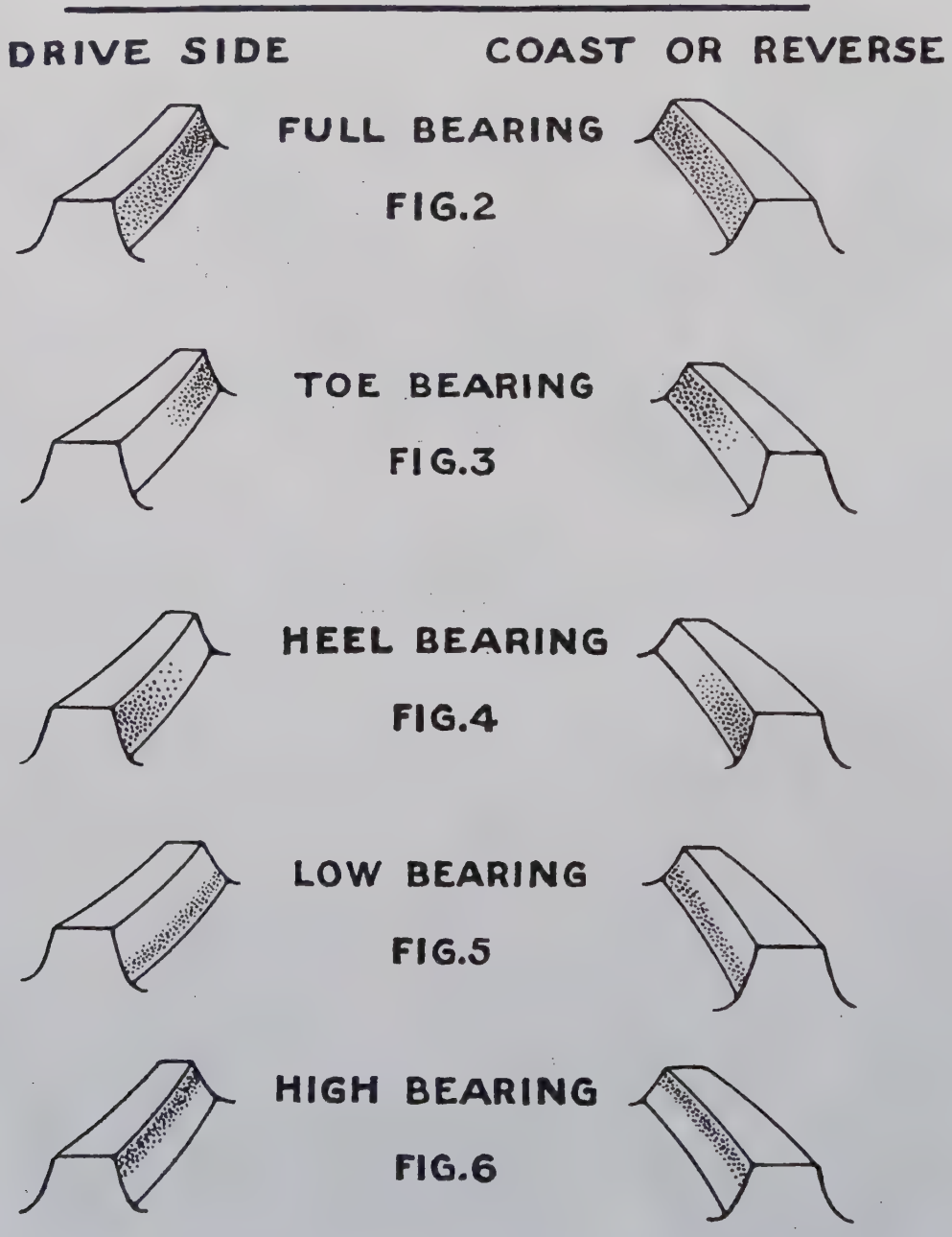


Illus. No. 44
Rear View of Differential and Carrier Assembly



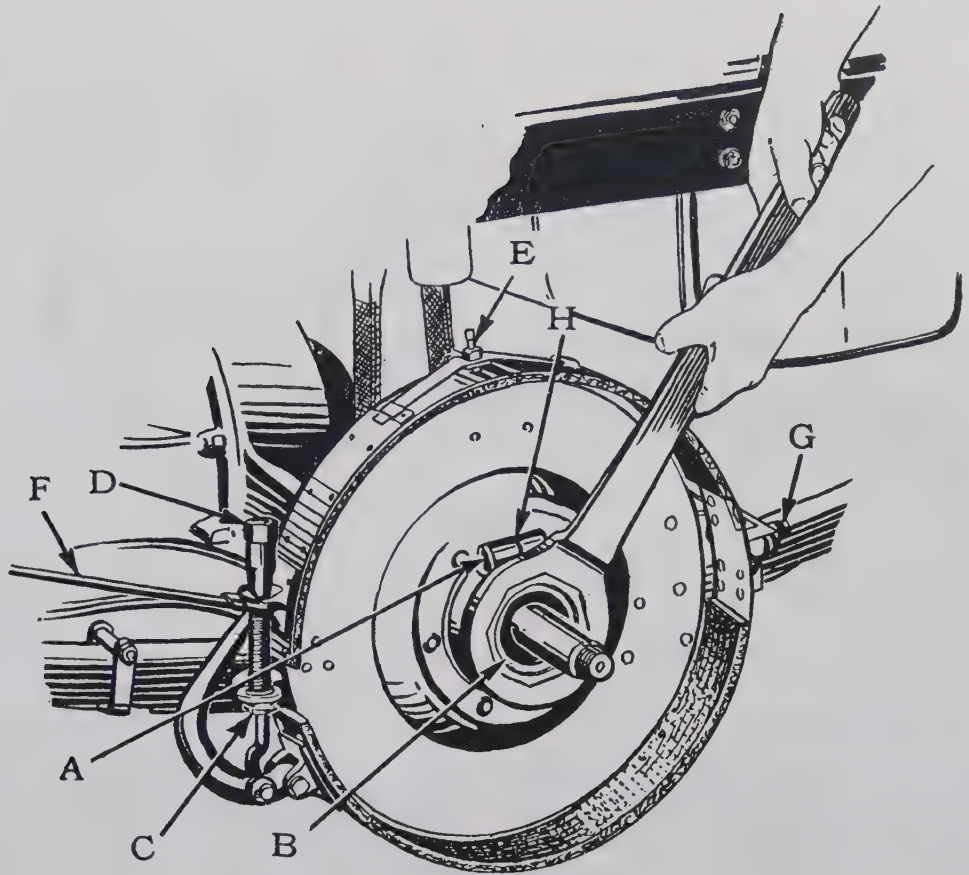
Illus. No. 45
Differential Disassembled



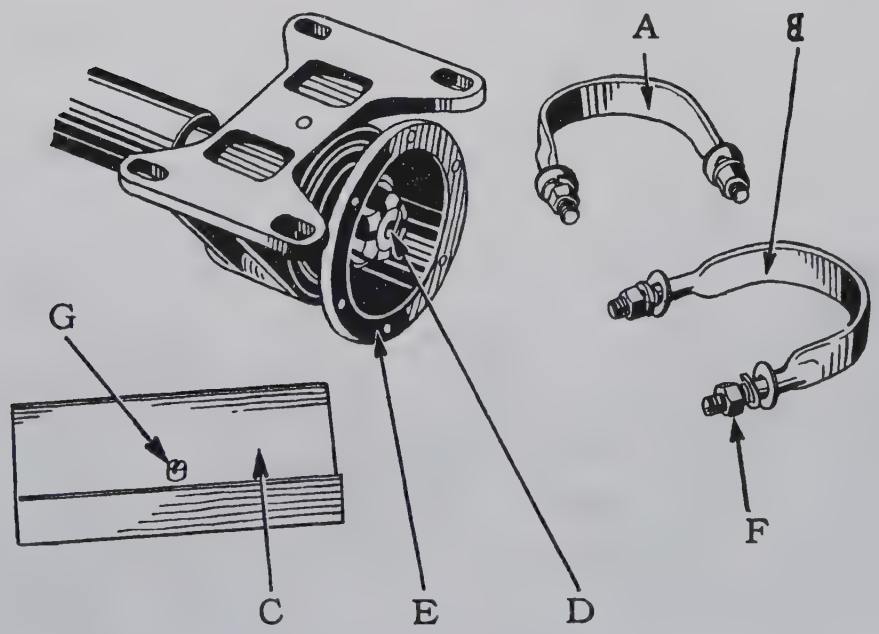


Illus. No. 46

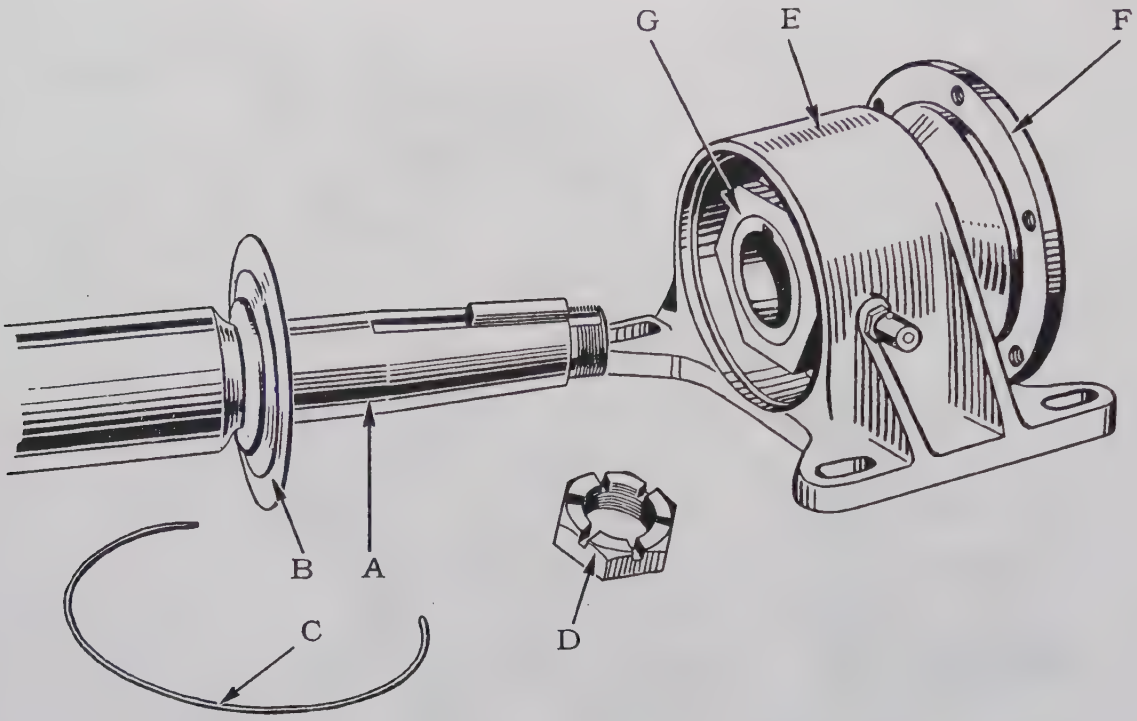
Rear Axle Ring Gear and Pinion Tooth Bearing Chart



Illus. No. 47
Adjusting Rear Axle Shaft Bearing

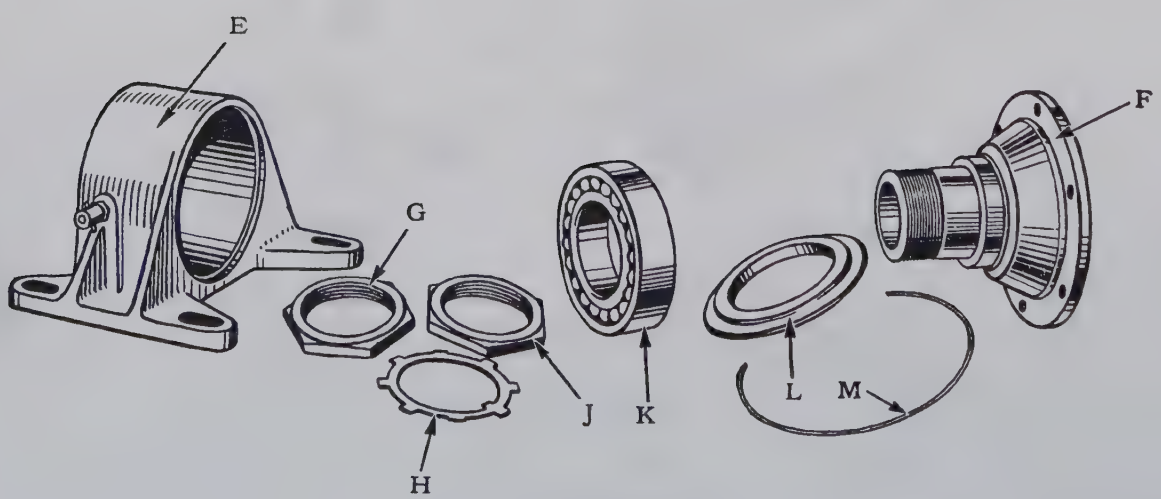


Illus. No. 48
Bus Front Propeller Shaft and Bearing Assembly. Used Previous to Serial Numbers Given in Operation Article No. 58



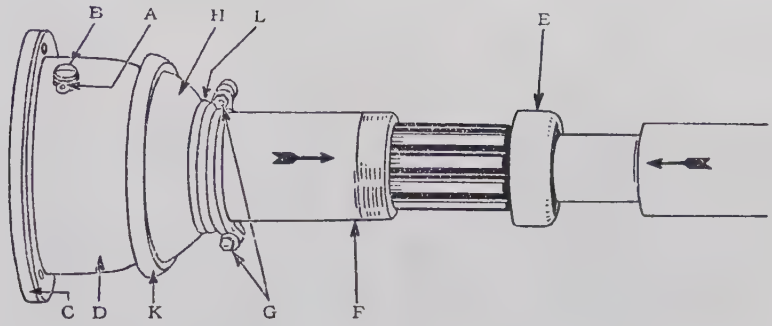
Illus. No. 49

Disassembling Bus Front Propeller Shaft Support Bearing. Used Previous to Serial Numbers Given in Operation Article No. 58



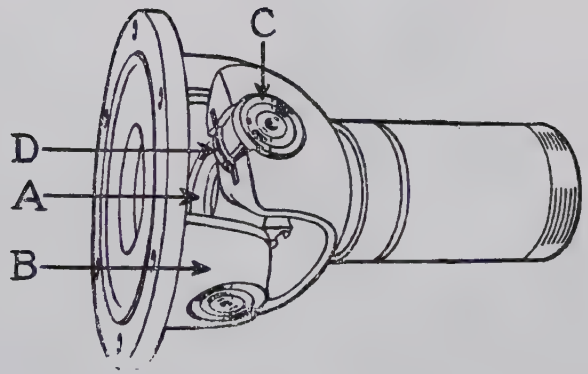
Illus. No. 50

Bus Front Propeller Shaft Support Bearing Disassembled



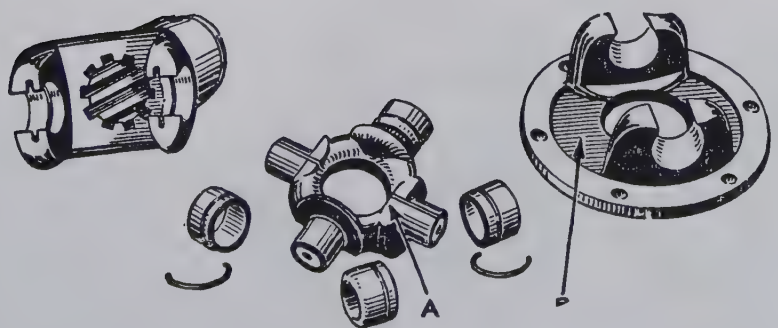
Illus. No. 51

Arrows Showing Proper Way to Assemble Front Universal to Propeller Shaft



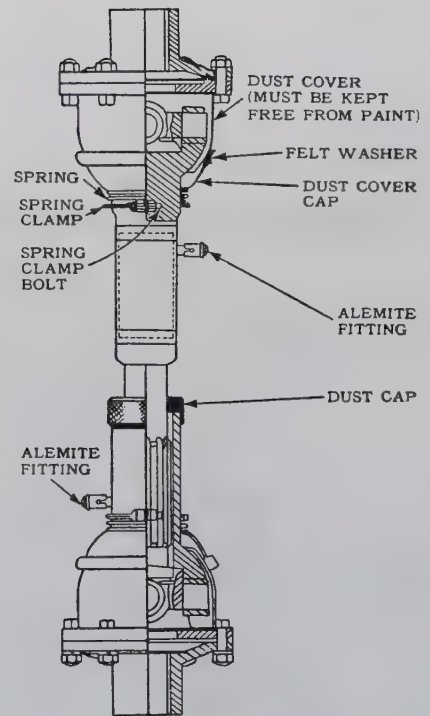
Illus. No. 52

Front Universal Joint Showing Bushing Lock Ring "D" in Position



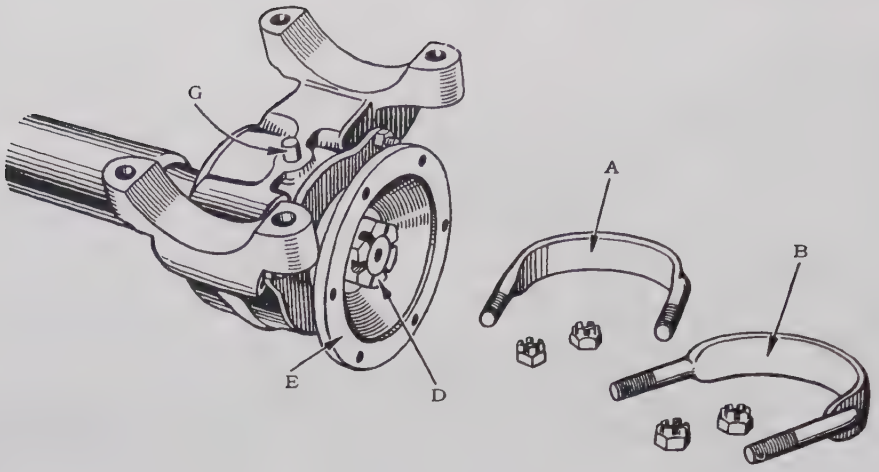
Illus. No. 53

Front Universal Joint Disassembled

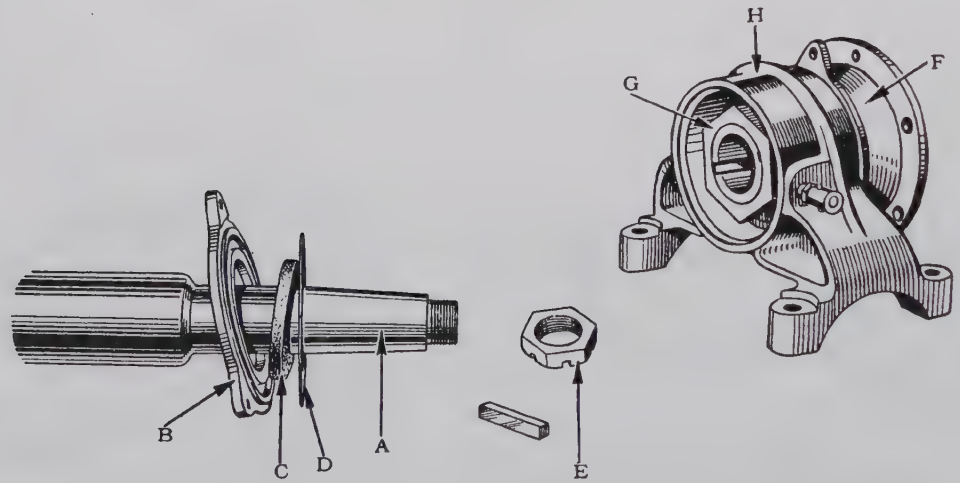


Illus. No. 54

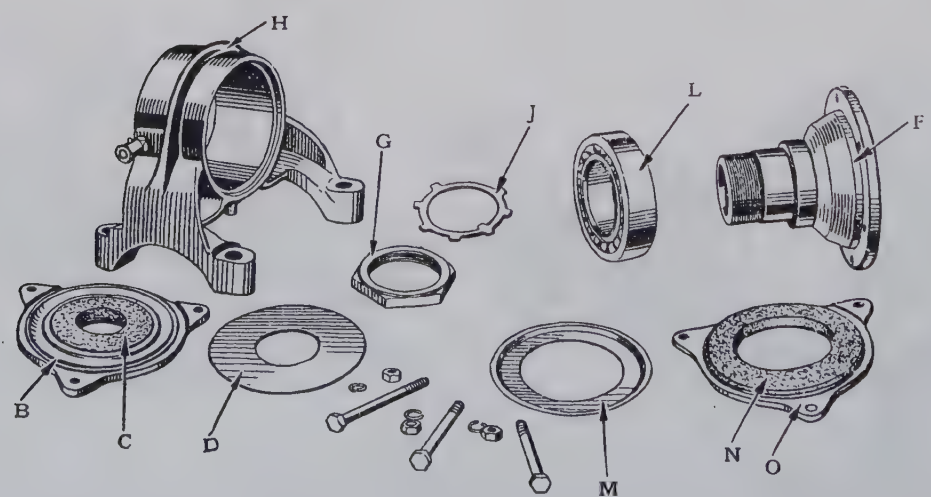
Sectional View of Universal Joint and Propeller Shaft Assembly



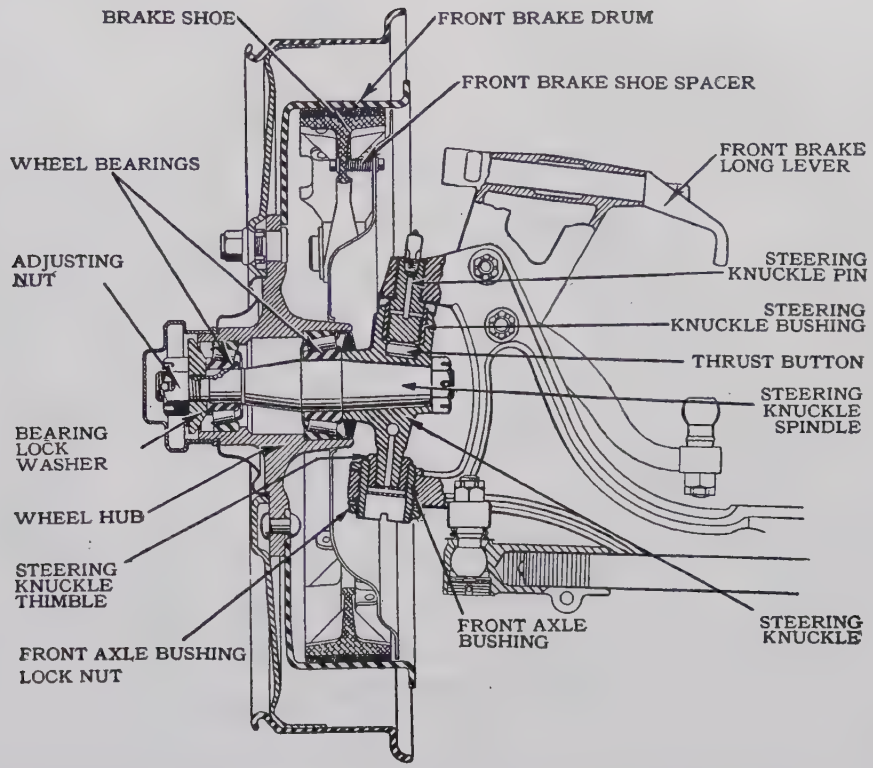
Illus. No. 55
Bus Front Propeller Shaft and Support Bearing Assembly Which Started With Serial Numbers as Given in Operation Article No. 58



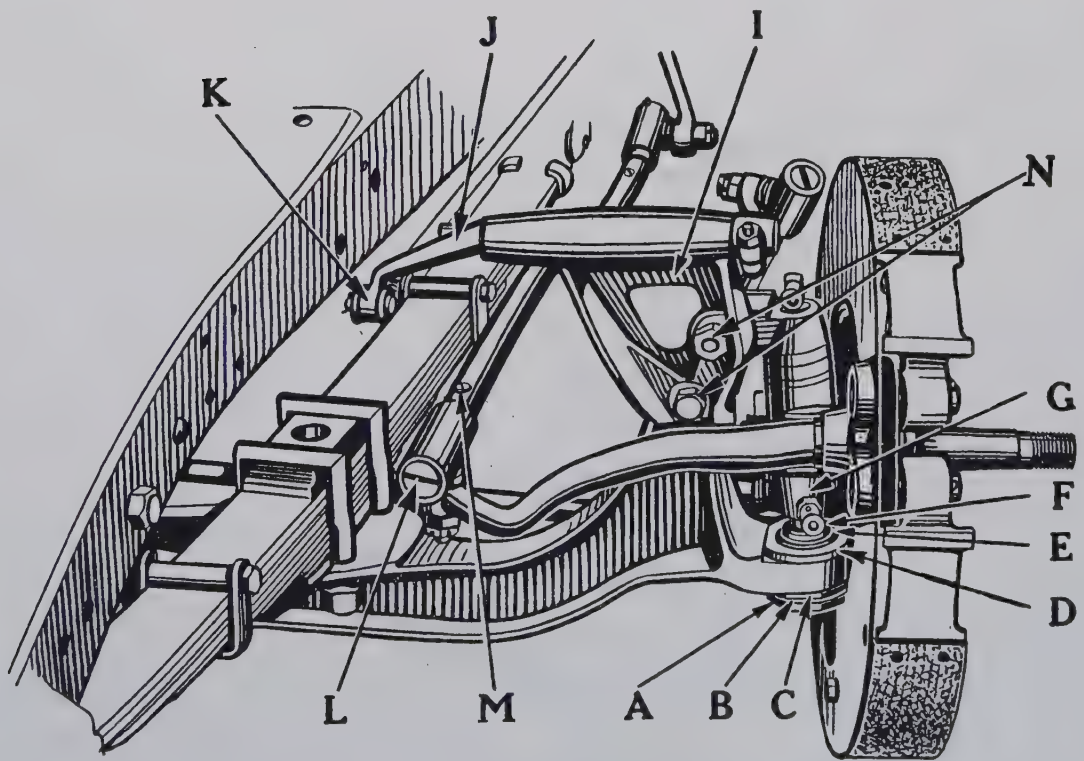
Illus. No. 56
Disassembling Bus Front Propeller Shaft Support Bearing



Illus. No. 57
Bus Front Propeller Shaft Support Bearing Disassembled



Illus. No. 58
Section Through Steering Knuckle (Commander Models)



Illus. No. 59
Front View of Left-Hand End of Front Axle
(Commander Models)

Insert in Volume One, Big Six Section, immediately following page 58.

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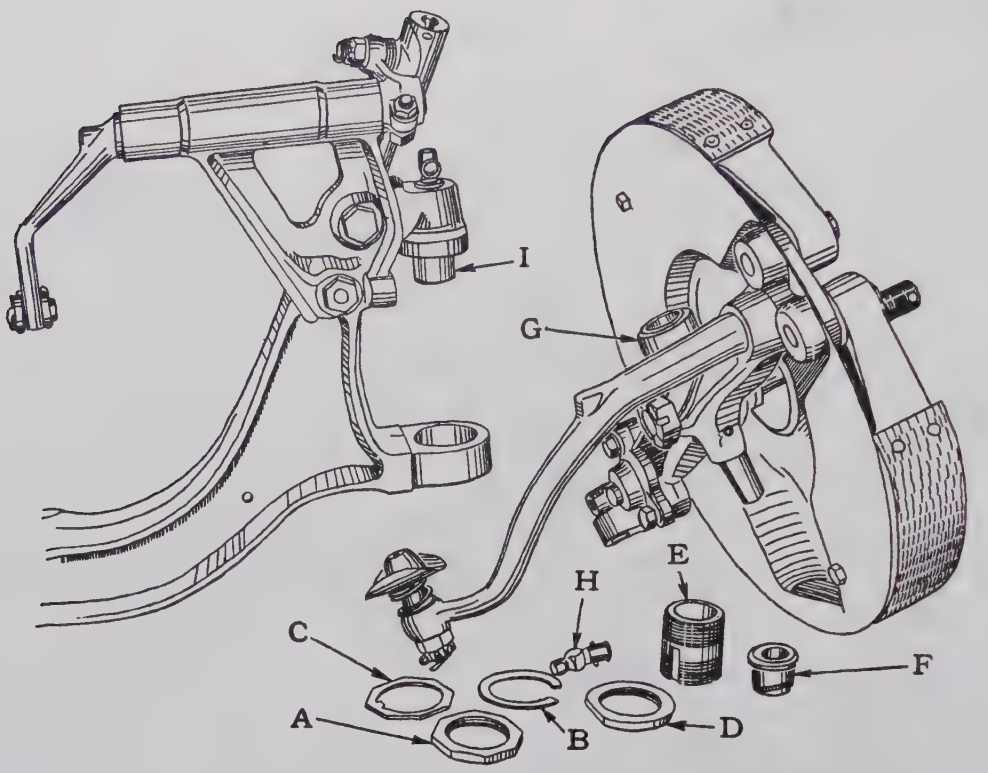
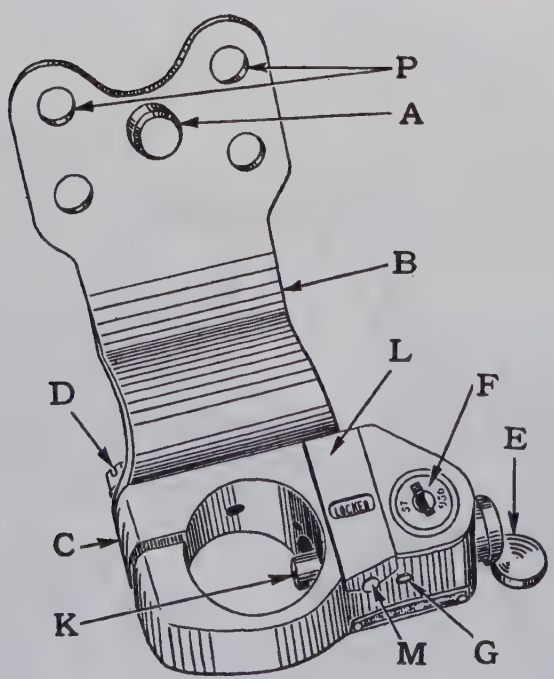
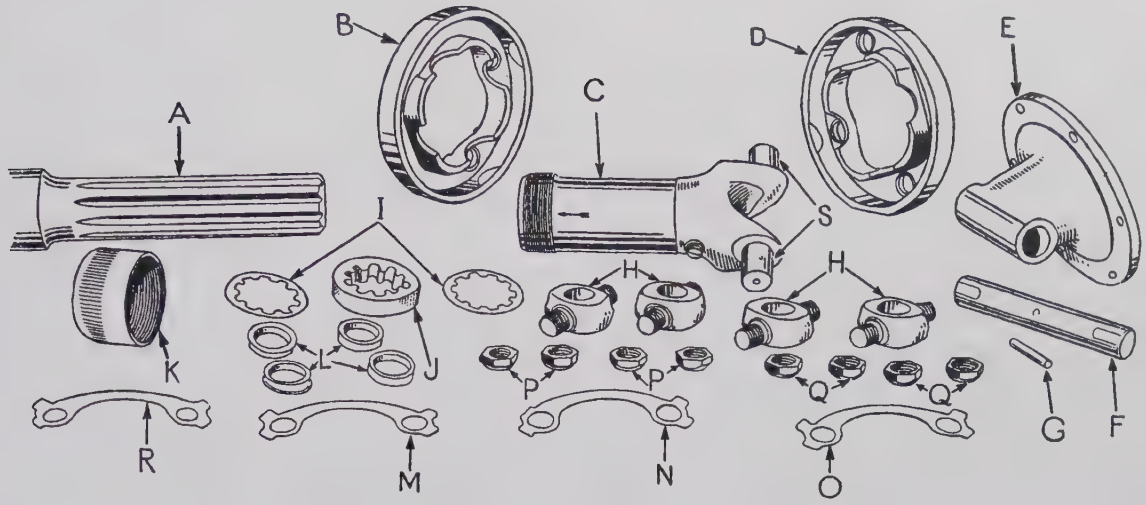


Illus. No. 60
Steering Knuckle Removed (Commander Models)



Illus. No. 61
Steering Gear Lock
(Ignition Switch Type)



Illus. No. 62
Front Universal Joint Disassembled
(Mechanics Universal Joint)

Insert in Volume One, Big Six Section, immediately after page 58-B.

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OPERATION ARTICLES

The following section is one containing instructions for disassembling, assembling and repairing various units. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised operation article will be carried at the bottom of the green sheet.

For example, the reader is interested in Operation Article No. 3, To Remove and Replace Steering Knuckle. Before he reads this, a glance at the bottom of the page will tell whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the Operation Article No. 3, such as 3-1 or 3-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ARTICLE No. 1

To Remove and Replace Front Wheel and Bearings

1. Place a jack under the front axle, raising it until the wheel to be removed is free from the ground.
2. Unscrew the hub cap that is threaded on the wheel hub.
3. Remove the cotter pin from the end of the steering knuckle spindle.
4. Unscrew the bearing adjusting nut shown in Illus. No. 1.
5. Remove the bearing retainer washer (Illus. No. 1).
6. The wheel and bearings can now be pulled off the steering knuckle.
7. The bearing cups are pressed into the wheel hubs. To remove them use a brass drift and tap the caps all around with a hammer. When possible, a press should be used to replace the bearing cups in the hubs.
8. Reverse operations to assemble the wheel and bearings.
9. Adjust the wheel bearings by turning the adjusting nut tight, as shown in Illus. No. 16, turning the wheel with one hand (in the direction of rotation when the car is moving forward) while tightening, to allow the bearings to seat properly. Then back off the adjusting nut until the wheel turns freely but with a minimum amount of side play. In testing the adjustment grasp the wheel at the top and bottom, never the sides, in order to avoid confusing bearing play with loose steering connections. (See Illus. No. 15).
10. Put in the cotter pin, using a new one. If, with the bearings properly adjusted, the cotter pin holes do not line up, back the nut off (never tighten) sufficiently to insert the pin.
11. Screw on the hub cap.
12. Remove the jack.

Tools Required—Jack, hub cap wrench, pliers, screwdriver, brass drift hammer.

ARTICLE No. 2

To Remove and Replace Steering Knuckle
(2 Wheel Brake Equipment)

1. Remove the front wheel (see Operation Article No. 1).
2. Remove the cotter pin, unscrew the plug "L" (Illus. No. 7) and lift the front end of the reach rod off of the ball bolt if working on the steering knuckle connected to the reach rod.
3. Remove the cotter pin and nut and drive out the cross tube clevis bolt "J" (Illus. No. 3).
4. Remove nut "P" and drive out steering knuckle lower pin cotter key (Illus. No. 3).
5. Remove front axle bushing lower nut "A", split washer "B" and flat lock washer "C" (Illus. No. 4).
6. Unscrew front axle bushing "D" (Illus. No. 4).
7. With a piece of strap iron "R" (Illus. No. 4) ½ inch by 2 inches by 2 feet, having a ⅜ inch hole drilled near one end, and bolt "F" (⅜ inch-24 thread) the steering knuckle pin "E" can be removed as shown in the Illus.
8. Remove the steering knuckle from the axle as shown in Illus. No. 5.

If it should be necessary to remove the steering knuckle bearing cup, Steering Knuckle Bearing Cup Puller (C.O. 427) is required. The new cup should be pressed in, using an arbor press for the operation. If a press is not available, drive the cup in, using a wood block and hammer.

If it is necessary to remove the steering knuckle arm, first remove the cotter pin and unscrew nut "Q" (Illus. No. 5). Then press out the steering knuckle arm on an arbor press or drive it out with a lead hammer and brass drift.

9. Reverse operations to assemble.

Adjust the steering knuckle bearing by turning up on front axle bushing "D" (Illus. No. 4) moving the steering knuckle back and forth while tightening, until the bearing is tight. This will allow the bearing to seat properly. Then back off

the bushing until the steering knuckle can be moved back and forth freely but has no play.

In replacing flat lock washer "C" the lug "K" may not be in alignment with slot "H" in bushing "D" and shoulder "I" on front axle. If this condition should exist after proper adjustment of the steering knuckle bearing is secured, the adjustment should not be disturbed, but flat washer "C" should be reversed. The lug "K", which is off center, will then be in another position and in proper alignment for installation (Illus. No. 3, 4 and 5). When assembling, grease the bearing thoroughly.

Tools Required—Jack, hub cap wrench, adjustable wrench, No. 29 and 31 open end wrenches, pliers, brass drift, hammer, steering knuckle bearing cup puller.

ARTICLE No. 3

To Remove and Replace Steering Knuckle

(4 Wheel Brake Equipment)

1. Remove the front wheel and bearings (see Operation Article No. 1).
2. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off of the ball bolt, if working on the steering knuckle connected to the reach rod.
3. Remove nut "A" (Illus. No. 6).
4. Support the steering knuckle at point "B" (Illus. No. 6) and drive the ball bolt out of the steering knuckle. Use a brass drift and hammer.
5. Remove clamp bolt "E" (Illus. No. 6) and drive off the lever "F" which is fastened to the lower end of the front brake connecting link.
6. Remove the steering knuckle bearing adjusting nut lock screw "A" (Illus. No. 7).
7. Unscrew nut "B" (Illus. No. 8) with the Front Axle Bushing Nut Wrench (C.O. 406).
8. After nut "B" (Illus. No. 7) is entirely loosened drive down on thimble "C" with a brass drift and hammer. This will remove thimble "C" and bushing "D" as in Illus. No. 9.
9. The steering knuckle will then drop down far enough to clear bearing "F" and can be removed as shown in Illus. No. 9.
10. Remove nut "B" (Illus. No. 9).
11. The steering knuckle thrust bearing cup can be removed with the puller C.O. 427. (See Vol. 8).
12. If necessary to completely disassemble the steering knuckle:

Remove the steering knuckle arm. (See Operation Article No. 11).

Remove the brake shoes. (See Operation Article No. 21, Vol. 2) or use the following operations:

A. Remove the cotter pins and the flat washers from pins "C" (Illus. No. 11).
B. Remove spacer bolts "M" and "L" (Illus. Nos. 11 and 13) together with the spacers, springs and washers.
C. Remove the screw and washer "J" (Illus. No. 11).
D. Remove both brake shoes at once, leaving spring "K" fastened to the shoes.
E. After the shoes are removed, unfasten spring 'K".

Remove the brake cam support. (See Operation Article No. 22, Vol. 2, or use the following operations:)

A. Remove screw "E" (Illus. No. 6) and drive off lever "F", leaving it fastened to connecting link "G" as shown in Illus. No. 13.
B. Remove the Woodruff key from cam "I" (Illus. No. 13) and remove the cam.
C. Remove nut "D" (Illus. No. 13).
D. Remove bolts 'H". Dust shield "N" can now be removed.
E. Remove screws "C" (Illus. No. 6) and the support can now be removed.

13. Reverse operations to replace.

After the steering knuckle is replaced, and before assembling the reach rod, cross tube or lock screw "A" (Illus. No. 8) adjust the steering knuckle bearing. Hold bushing "D" stationary with an adjustable wrench so that the flat side of the bushing is parallel with the shoulder milled on the under side of the axle, and turn nut "B" to the left with the front axle bushing nut wrench, moving the steering knuckle back and forth while tightening until the bearing is tight. This allows

ARTICLE NO. 3-1

To Remove and Replace Steering Knuckle

The following revision in Article No. 3 applies to Big Six 120-inch Wheelbase Cars after serial No. 4,000,001.

1. Remove the front wheel and bearings. (See Operation Article No. 1).

2. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off of the ball bolt, if working on the steering knuckle connected to the reach rod.

3. Remove the cross tube ball bolt nut "A" (Illus. No. 6).

4. Support the steering knuckle at point "B" and drive the ball bolt out of the steering knuckle using a brass drift and hammer.

5. Remove the clamp bolt "E" (Illus. No. 6) and drive off the lever "F," which is fastened to the lower end of the front brake connecting link.

6. Unscrew the front axle bushing lower nut "A", and remove lock washers "B" and "C" (Illus. No. 59).

7. By means of the slots in the lower end of the front axle bushing "E" (Illus. No. 60) unscrew it from the upper nut and remove the bushing.

8. Remove thimble "F" by driving it down with a brass drift and hammer.

9. Unscrew the alemite grease cup "H".

10. The steering knuckle will then drop down far enough to clear pin "I" and can be removed.

11. The steering knuckle thrust button (Illus. No. 58) can be removed by tapping the steering knuckle while it is held upside down.

12. If necessary to remove the steering knuckle upper bushing. This can be pulled with the special puller, C. O. 410. (See Vol. 8).

13. If necessary to completely disassemble the steering knuckle. Remove the steering knuckle arm (See Operation Article No. 11).

14. To remove the brake shoes use the following operations:

A. Remove the cotter pins and the flat washers from the pins "C" (Illus. No. 13).
B. Remove the spacer bolts "M" and "L" together with the spacers, springs and washers.
C. Remove the screw and washer "J".
D. Remove both brake shoes at once leaving spring "K" fastened to the shoes until they are removed.

15. To remove the brake cam support use the following operations:

A. Remove screw "E" (Illus. No. 13) and drive off lever "F" leaving it fastened to the connecting link "G" as shown in (Illus. No. 13).
B. Remove the woodruff key from cam "I" and remove the cam.
C. Remove cotter pin and nut "D".
D. Remove bolts "H". Dust shield "N" can now be removed.
E. Remove screws "C" (Illus. No. 6). The cam support can now be removed.

16. Reverse operations to replace the steering knuckle. Install steering knuckle and adjust lower bushing before assembling the brake cam support, brake shoes, or cross tube.

Turn bushing "E" (Illus. No. 59) up by means of the slot in the lower end, until the bearing is tight. Now back off bushing "E" until the steering knuckle moves back and forth freely but has no play.

If the key on lock washer "C" (Illus. No. 60) will not engage the slot in bushing "E" turn the washer over.

The key is offset and will come in a different position. If it is necessary to move bushing "E" in order to line up the key with the bushing, always loosen the bushing.

Note—When replacing the brake shoes be sure to mount each shoe on the same pin "C" (Illus. No. 11) from which it was removed.

If for any reason this is not done or if new brake lining has been installed, proceed as follows: After all parts including the front wheel has been assembled—

A. Remove clevis pin "K" (Illus. No. 7).
B. Loosen the two screws "C" (Illus. No. 6).
C. Pull the lever "J" (Illus. No. 7) back as far as possible, thus expanding the brake shoes tightly against the drum. This will locate the brake cam support

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in the proper position. Try to insert a .020 inch feeler gauge between the shoes and drum, especially at the center of the shoes to determine if the shoes are seating properly. With the lever held in position tighten the screws "C" (Illus. No. 6).

The above operations will compensate for any small inequalities in the brake shoes or in the thickness of the lining and will equalize the movement of the shoes.

When assembling the reach rod plug "L" (Illus. No. 59) it should be screwed in approximately flush with the end of the reach rod or just so the cotter pin can be installed.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, brass drift, hammer and steering knuckle bushing puller C. O. 410.

the bearing, cup and thimble to seat properly. Then back off nut "B" until the steering knuckle can be moved back and forth freely but has no play.

If one of the grooves in nut "B" does not now line up with the hole in the axle, permitting installation of lock screw "A" hold bushing "D" stationary and *loosen* nut "B" enough to install the lock screw. Make sure that the square bushing lock which is held in place by lock screw "A" engages both the flat on the bushing and the millled shoulder on the axle.

Note—When reassembling the brake shoes be sure to mount the shoes on the same pin "C" (Illus. No. 11) from which they were removed.

If for any reason this is not done, or if new brake lining has been put on the shoes proceed as follows after all parts, including the front wheel have been assembled:

A. Remove the clevis pin "K" (Illus. No. 7).
B. Loosen the two screws "C" (Illus. No. 6).
C. Pull the lever "J" (Illus. No. 7) back as far as possible thus expanding the brake shoes tightly against the drums. This will locate the brake cam support in the proper position. Try to insert a .020 inch feeler gauge between the shoes and the drum to determine if shoes are seating properly. Apply the feeler at the center of each shoe. The clearance should be too small for it to enter.
D. With the lever "J" held in this position tighten the screws "C" (Illus. No. 6).

The above operations will compensate for any small inequalities in the brake shoes or in the thickness of the lining and will equalize the movement of the shoes.

When assembling the reach rod, plug "L" (Illus. No. 7) should be screwed in approximately flush with the end of the rod or just so that the cotter pin can be installed.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, front axle bushing nut wrench, brass drift, hammer.

ARTICLE No. 4

To Remove and Replace Steering Knuckle Thrust Bearing

1. Remove the steering knuckle. (See Operation Article No. 2 or 3).
2. Remove the grease cup in upper end of the bearing "F" (Illus. No. 10).
3. Drive out the bearing "F" (Illus. No. 10), using a brass drift and hammer.
4. Felt "C", retainers "B" and "D" will be removed with the bearing.
5. Reverse operations to replace.

Press the bearing back in the axle as described under C.O. 421, in Vol. 8.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, front axle bushing nut wrench, brass drift, hammer, steering knuckle thrust bearing installing fixture.

ARTICLE No. 5

To Remove and Replace Steering Cross Tube

(2 Wheel Brake Equipment)

1. Remove the cotter pin and nut from clevis bolt "J" (Illus. No. 3). Perform the same operation on the left hand end.
2. Drive out both clevis bolts.
3. Reverse operations to replace.

If the adjusting clevis has been removed it will be necessary to align the front wheels. (See Operation Article No. 8).

Tools Required—Pliers, No. 27 and 31 open end wrenches, hammer, wheel aligning gauge.

ARTICLE No. 6

To Remove and Replace Steering Cross Tube

(4 Wheel Brake Equipment)

1. Remove nut "A" (Illus. No. 6).
2. Support the steering knuckle at point "B" and drive the cross tube bolt out of the steering knuckle.
3. Remove spring "D" (Illus. No. 20) and cover "E".
4. Remove cotter pin "G" (Illus. No. 20) and unscrew plug "F".
5. Ball bolt "C" can now be removed from the cross tube end.
6. Repeat the above operations at the other end of the cross tube.
7. If necessary to disassemble the cross tube, loosen bolt "J" (Illus. No. 20) at each end and unscrew each cross tube end "H". The right hand end has right hand threads and the left hand end, left hand threads.
8. Reverse operations to assemble. If the cross tube ends have been removed it will be necessary to align the front wheels. (See Operation Article No. 9).
9. When assembling plug "F" (Illus. No. 20) turn it in as far as possible and then unscrew it one-half turn. If the cotter pin holes do not line up in this position, unscrew it just enough further to insert the cotter pin.

Tools Required—No. 25 and 31 open end wrenches, lead hammer, pliers, screw driver, block to support steering knuckle, pipe wrench.

ARTICLE No. 7

To Remove and Replace Steering Cross Tube Ball Bolt

(4 Wheel Brake Equipment)

1. Remove nut "A" (Illus. No. 6).
2. Support the steering knuckle at point "B" and drive the cross tube ball bolt out of the steering knuckle.
3. Remove spring "D" (Illus. No. 20) and cover "E".
4. Remove cotter pin "G" (Illus. No. 20) and unscrew plug "F".
5. Ball bolt "C" can now be removed from the cross tube end.
6. Reverse operations to assemble.
7. When assembling plug "F" (Illus. No. 20) turn it in as far as possible and then unscrew it one-half turn. If the cotter pin holes do not line up in this position, unscrew it just enough further to insert the cotter pin.

Tools Required—No. 25 and 31 open end wrenches, lead hammer, pliers, screw driver, block to support steering knuckle.

ARTICLE No. 8

To Line Up Front Wheels

(2 Wheel Brake Equipment)

1. Measure between the felloes of the front wheels, taking measurements in front and in back gauge C.O. 151. The difference should be 1/8 of the axle (Illus. No. 31, Vol. 8) with aligning inch with balloon tire equipment and 1/4 to 3/8 inch with high pressure tires, the front measurement being the shorter. (See C.O. 151, Vol. 8).
2. If the measurement of the wheels shows that the toe-in is not correct, remove the cotter pin and nut from the adjustable clevis bolt "J" (Illus. No. 3).
3. Drive out the clevis bolt.
4. Remove the cotter pin and loosen the nut on the clamp bolt "M" (Illus. No. 3).

ARTICLE NO. 4-1

To Remove and Replace Steering Knuckle Pin

The following revision in Article No. 4 applies to Big Six 120-inch Wheelbase Cars after serial No. 4,000,001.

1. Remove the steering knuckle (See Operation Article No. 3-1).
2. Remove the grease cup in the upper end of pin "P" (Illus. No. 60).
3. Drive out the pin using a brass drift and hammer.
4. The oil felt and retainer will be removed with the pin.
5. Reverse operations to replace.

Press the pin back into the axle using the service tool No. C. O. 421 (See Vol. 8).

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, brass drift, hammer and service tool C. O. 421.

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5. If the measurement of the wheels shows that they do not toe in enough, the cross tube is too short and the adjustable clevis should be turned so that it unscrews; if the wheels toe in too much, screw in on the clevis enough to obtain proper alignment.

6. Place the adjustable clevis bolt and clevis back in position and check the alignment.

Tools Required—Pliers, No. 27 and 31 open end wrenches, wheel aligning gauge and hammer.

ARTICLE No. 9

To Line Up Front Wheels

(4 Wheel Brake Equipment)

1. Measure between the felloes of the front wheels taking measurements in front and in back of the axle (Illus. No. 31, Vol. 8) with aligning gauge C.O. 151. The difference should be ⅛ inch with balloon tire equipment and ¼ to ⅜ inch with high pressure tires, the front measurement being the shorter. (See C.O. 151, Vol. 8).

2. Loosen bolt "J" (Illus. No. 6) at each end of the cross tube.

3. The right hand end of the tube carries a right hand thread and the left-hand end a left hand thread.

If the measurement of the wheels shows that they toe in too much, the cross tube is too long. In that case turn cross tube "K" (Illus. No. 6) so that it screws further into the ends "H".

If the measurement of the wheels shows that they do not toe in enough, the cross tube is too short and should be turned so that it unscrews from the cross tube ends.

4. After adjustment is made and the aligning gauge shows that the wheels are in alignment, an end of the cross tube should be visible in each hole "I" (Illus. No. 20).

If not, proceed as follows:

Completely unscrew cross tube "K" (Illus. No. 6) from ends "H".

Screw cross tube "K" back into ends "H" engaging each end at the same time. Turn the cross tube until the wheels are once more in alignment. Each end of the cross tube will then be visible in sight holes "I".

5. Tighten clamp screws "J".

Tools Required—No. 25 open end wrench, pipe wrench.

ARTICLE No. 10

To Remove and Replace Steering Knuckle Arm

(2 Wheel Brake Equipment)

1. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) in the front end of the reach rod and lift the reach rod off the ball bolt. This operation is necessary only when working on the left steering knuckle arm on left hand control and the right steering knuckle arm on right hand control. To remove the other steering knuckle arm, start at operation 2.

2. Remove the cotter pin and nut from the cross tube clevis bolt as shown at "J" (Illus. No. 3).

3. Drive out the clevis bolt.

4. Remove the cotter pin and unscrew nut "Q" (Illus. No. 5) holding the arm into the steering knuckle.

5. Drive steering knuckle arm "R" (Illus. No. 5) out of the steering knuckle, using a lead hammer or brass drift and hammer.

6. Reverse operations to assemble. Make sure that the arm is drawn tight into the steering knuckle.

When assembling the front end of the reach rod, plug "L" (Illus. No. 7) should be screwed in approximately flush with the end of the rod or just so that the cotter pin can be installed.

Tools Required—Pliers, No. 31 and 33 open end wrenches, hammer and large screw driver.

ARTICLE No. 11

To Remove and Replace Steering Knuckle Arm

(4 Wheel Brake Equipment)

1. Remove the front wheel and bearings (See Operation Article No. 1).
2. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off of the ball bolt.
3. Remove the cotter pin and unscrew nut "D" (Illus. No. 11).
4. Drive out the steering knuckle arm, using a lead hammer or brass drift and hammer.

When assembling the reach rod, plug "L" (Illus. No. 7) should be screwed in approximately flush with the end of the rod or just so that the cotter pin can be installed.

The steering knuckle arm will be found on the left side on left-hand control cars and on the right side on right-hand control cars. The above operations will apply to both.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 31 open end wrench, brass drift, hammer.

ARTICLE No. 12

To Remove and Replace Steering Knuckle Arm Bushing

(2 Wheel Brake Equipment)

1. Remove the steering knuckle arm. (See Operation Article No. 10).
2. Drive out the old bushing with a drift and hammer.
3. Press in the new bushing or drive it in with a wooden block and hammer.
4. Reverse Operation Article No. 10 to assemble.

Tools Required—Pliers, No. 31 and 33 open end wrenches, screw driver, ¾ inch drift and hammer.

ARTICLE No. 13

To Remove and Replace Front Wheel Spindle

(4 Wheel Brake Equipment)

1. Remove the front wheel and bearings. (See Operation Article No. 1).
2. Remove the steering knuckle. (See Operation Article No. 3).
3. Remove cotter pin and nut "G" (Illus. No. 7).
4. Press the spindle out of the steering knuckle.
5. Reverse operations to assemble.

Caution—This operation should not be performed unless absolutely necessary and then only with the use of a heavy arbor press in order to press the spindle back firmly in place. It is very important that the spindle be pressed in with a heavy arbor press instead of depending on the nut to draw it in place as there must be no possibility of it working loose.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, steering knuckle bearing adjusting nut spanner wrench, brass drift, hammer, arbor press.

ARTICLE No. 14

To Remove and Replace Steering Reach Rod

1. Remove the cotter pin and unscrew plug "L" (Illus. No. 7) in the front end of the rod.
2. Repeat operation 1 on the rear end of the rod.
3. Remove the reach rod from the ball bolts.
4. To replace make sure that the springs and spring cups are assembled properly and the sockets packed with grease. The plugs should be screwed into the reach rod so that the ends of the plugs are approximately flush with the ends of the rod or just so the cotter pins can be installed.

Tools Required—Pliers and large screw driver.

ARTICLE No. 15

To Remove and Replace Steering Reach Rod Ball Bolt

1. Remove the cotter pin and unscrew the plug in the end of the reach rod where the ball bolt is to be removed.
2. Remove the reach rod from the ball bolt.
3. Remove the cotter pin and nut from the ball bolt to be replaced.
4. Drive out the ball bolt, carefully supporting the arm to prevent it from being sprung.
5. Reverse operations to assemble.
6. When reassembling the reach rod make sure that the springs and spring cups are assembled properly and the sockets packed with grease. The plug should be screwed into the reach rod so that the end of the plug is approximately flush with the end of the rod or just so the cotter pin can be installed.

Tools Required—Pliers, large screw driver and hammer.

ARTICLE No. 16

To Remove and Replace Front Wheel Hub Assembly

(Wood Wheel Equipment)

1. Remove the front wheel. (See Operation Article No. 1).
2. Drive out the bearing cups, using a brass drift and tapping the cups all around with a hammer.
3. Place the assembly on a bench and file off the peened ends of the 12 hub bolts "A" (Illus. No. 18).
4. Remove the hub bolt nuts and drive out the bolts.
5. Remove the hub flange and press out the wheel hub.
6. Press in the new hub and replace the flange.
7. Install 12 new bolts (always use new bolts).
8. Put on the nuts and draw them tight. Peen over the ends of the bolts after tightening.
9. Paint the bolts to match the wheel hub.
10. Replace the bearing cups, using an arbor press if possible.
11. Replace the wheel. (See Operation Article No. 1).

Tools Required—Jack, hub cap wrench, pliers, brass drift, hammer and No. 29 open end wrench.

ARTICLE No. 17

To Remove and Replace Front Axle, Wheels and Springs Assembly Complete

(2 Wheel Brake Equipment)

1. If no chain hoist is available, block up the frame just back of the front springs until the front wheels are clear of the ground. Method of blocking is shown in Illus. No. 35.

2. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off the ball bolt.

3. Remove the two cotter pins and nuts at the rear spring shackle and drive out the two shackle bolts. Perform this operation on front springs.

4. Remove the two front spring front bolts by removing the cotter pins and nuts and driving out the bolts. The axle and springs assembly can now be removed.

5. Reverse operations to reassemble.

Tools Required—Jack, blocking, No. 33, 29 and 25 open end wrenches, pliers, screw driver, brass drift and hammer.

ARTICLE No. 18

To Remove and Replace Front Axle, Wheels and Springs Assembly Complete

(4 Wheel Brake Equipment)

1. If no chain hoist is available, block up the frame just back of the front springs until the front wheels are clear of the ground. Method of blocking shown in Illus. No. 35.

2. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off the ball bolt.

3. Remove clevis pin "K". (Illus. No. 7).

4. Remove the two cotter pins and nuts at the rear spring shackle and drive out the two shackle bolts. Perform this operation on both sides.

5. Remove the two front spring front bolts by removing the cotter pins and nuts and driving out the bolts.

The axle and springs assembly can now be removed.

6. Reverse operations to assemble.

Tools Required—Jack, blocking, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, brass drift and hammer.

ARTICLE No. 19

To Remove and Replace Front Axle

(2 Wheel Brake Equipment)

1. If no chain hoist is available, block up the frame just back of the front springs until the front wheels are clear of the ground. The method of blocking is shown in Illus. No. 35.

2. Remove the front wheels. (See Operation Article No. 1).

3. Remove the cotter pin, unscrew plug "L" (Illus. No. 7) and lift the front end of the reach rod off the ball bolt.

4. Remove the eight nuts "C" (Illus. No. 17) on the four main spring clips holding the axle to the springs. The axle assembly can now be removed.

5. Place the axle in a vise and remove the steering knuckle and cross tube. (See Operation Article No. 2).

6. Reverse operations to assemble.

Tools Required—Jack, blocking, No. 33, 29 and 25 open end wrenches, pliers, hub cap wrench, screw driver, brass drift and hammer.

ARTICLE No. 20

To Remove and Replace Front Axle

(4 Wheel Brake Equipment)

1. If no chain hoist is available, block up the frame just back of the front springs until the front wheels are clear of the ground. The method of blocking is shown in Illus. No. 35.

2. Remove the front wheels. (See Operation Article No. 1).

3. Remove the steering knuckles. (See Operation Article No. 3).

ARTICLE NO. 14-1

To Remove and Replace Steering Reach Rod

The following revision in Article No. 14 applies to Big Six cars after serial No. 4011023.

1. Remove the cotter pin and unscrew plug "L" (Illus. No. 59) in the front end of the rod.
2. Repeat operation 1 on the rear end of the rod.
3. Remove the reach rod from the ball bolts.
4. To replace make sure that the springs and spring cups are assembled properly and all parts are clean and free from grit. The plugs "L" (Illus. No. 59) should be screwed into the reach rod so that the ends of the plugs are approximately flush with the ends of the rod or just so the cotter pins can be installed.
5. Remove the oil plugs "M" in each end of the reach rod, fill with medium to heavy engine oil and replace the plugs.

Tools Required—Pliers and large screw driver.

ARTICLE NO. 15-1

To Remove and Replace Steering Reach Rod Ball Bolt

The following revision in Article No. 15 applies to Big Six cars after serial No. 4011023.

1. Remove the cotter pin and unscrew the plug "L" (Illus. No. 59) in the end of the reach rod where the ball bolt is to be removed.
2. Remove the reach rod from the ball bolt.
3. Remove the cotter pin and nut from the ball bolt to be replaced.
4. Drive out the ball bolt, carefully supporting the arm to prevent it from being sprung.
5. Reverse operations to assemble.
6. When reassembling the reach rod make sure that the springs and spring cups are assembled properly and all parts are clean and free from grit. The plug "L" should be screwed into the reach rod so that the end of the plug is approximately flush with the end of the rod or just so the cotter pin can be installed.
7. Remove the oil plugs "M" in each end of the reach rod, fill with medium to heavy engine oil and replace the plugs.

Tools Required—Pliers, large screw driver, adjustable wrench, brass drift and hammer.

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4. Remove clevis pin "K" (Illus. No. 7).

5. Remove bolts "N" (Illus. No. 7) and remove bracket "I" together with connecting link.

6. Remove the eight nuts on the four main spring clips holding the axle to the springs. The axle can now be removed.

7. If necessary to remove thrust bearing "F" (Illus. No. 10) take the axle to an arbor press and press out the bearing.

8. Reverse operations to assemble.

Tools Required—Jack, blocking, hub cap wrench, pliers, screw driver, No. 25, 29 and 33 open end wrenches, adjustable wrench, steering knuckle bearing adjusting nut spanner wrench, brass drift and hammer.

ARTICLE No. 21

To Remove and Replace Steering Arm

1. Remove the cotter pin, unscrew the plug in the rear end of the reach rod and remove the reach rod from steering arm.

2. Remove nut "A" (Illus. No. 21) and pull off steering arm "C". Use special steering arm puller according to type of arm. (See Vol. 8 and Tool Catalog).

3. Reverse operations to assemble.

When assembling the reach rod, the plug should be screwed in approximately flush with the end of the rod or just so that the cotter pin can be installed.

Tools Required—Screw driver, pliers, No. 27 and 33 open end wrenches, hammer, steering arm puller.

ARTICLE No. 22

To Remove and Replace Steering Gear Assembly

1. Take out the two wood screws holding the small floor board and remove the board.

2. Disconnect the accelerator. With the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.

3. Take out the screws holding the toe plate in the upper corner of the toe board and remove the plate.

4. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.

5. Disconnect the horn push button cable at the junction block and pull the cable through the clips at the rear end of the engine.

6. Unscrew the horn button (if the car is equipped with this type button) being careful not to loose the coil spring on the inside. In case of the large type button, remove the small set screw in the lighting switch lever hub.

7. Remove the horn button leaving the cable attached. The cable can be pulled out through the top of the steering post.

8. Remove the carburetor. See Operation Article No. 48, Vol. 3, or use the following operations:

A. Loosen the two clamp screws "W" and "X" (Illus. No. 22) holding the choke control tube and choke wire to the carburetor. The tube and wire can now be disconnected from the carburetor.

B. Shut off the gasoline by means of the valve under the vacuum tank.

C. Disconnect the vacuum tank to carburetor feed pipe at the carburetor.

D. Disconnect the hand throttle connection at "F" (Illus. No. 22) and the foot accelerator connection at "E".

E. Remove the two flange bolts holding the carburetor to the intake manifold and remove the carburetor.

9. Remove the end of the accelerator rod fastened to the rocker arm on the steering gear case.

10. Loosen the clamp screws holding the lighting switch and gear at the lower end of the

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PRINTED IN U. S. A.

switch and remove the lighting switch and gear. Leave the switch lying in the side pan, with the wiring connected.

11. Remove the clutch and brake pedals. See Operation Article No. 4, Operations 6 to 9, Vol. 6, or use the following operations:

A. Loosen the clamp screw holding the clutch pedal adjusting lever to the shifter shaft and drive off the clutch pedal arm and adjusting lever.

B. Remove the key from the shifter shaft.

C. Remove brake rod clevis pin "D" (Illus. No. 23) also the clevis pin "C" on hydraulic brake equipment.

D. Remove brake pedal arm "B" from the clutch shifter shaft.

12. If working on an assembly not equipped with a steering gear lock, remove the two cap screws holding the steering post bracket cap and remove the cap.

If working on a steering gear with a lock, see Operation Articles No. 31 and 32 to remove the lock.

13. Remove nut "A" (Illus. No. 21) and pull off steering arm "C".

14. Remove the four bolts "B" holding the steering gear bracket to the frame.

15. The steering gear assembly can now be removed.

16. Reverse operations to replace.

When replacing the lighting switch, pull the lighting switch lever on the steering wheel, down so that the word "curb" on the lever hub is at the top. Turn the lighting switch shaft clockwise (viewed from the top) as far as possible. Put the switch in place with the conduit hole to the inside and with the gear on the lower end of the shaft turned clockwise so as to engage the last tooth with the corresponding tooth of the gear on the lighting switch lever tube.

Tools Required—Screw driver, pliers, No. 23, 25, 27 and 33 open end wrenches, hammer, steering arm puller C.O. 412.

ARTICLE No. 23

To Disassemble and Assemble Steering Gear Assembly After Being Removed from Car

1. Remove the two screws holding the lighting switch upper lever and remove the lever.

2. Loosen the clamp screw on the lighting switch lever bracket and remove the bracket.

3. Loosen the gear clamp screw at the lower end of the lighting switch tube and pry the gear off of the tube. Both tubes can now be pulled out.

4. Remove the steering post nut, using special wrench C.O. 405.

5. Unscrew two of the six screws "D" (Illus. No. 25) opposite each other in the steering wheel hub.

6. Apply the universal puller as shown in Illus. No. 25 and pull off steering wheel. (See C.O. 71, Vol. 8). On metal spoke steering wheels use puller C.O. 132 Illus. No. 26. (See Vol. 8).

7. Remove the key from the steering post.

8. Loosen the steering post jacket clamp bolt "C" (Illus. No. 24) and remove the jacket.

9. Remove the five bolts holding cover "J" and remove the cover together with worm gear "G" and thrust washer "H" (Illus. No. 28).

10. Remove the two screws holding the lighting switch bracket and remove the bracket, being careful not to lose the spring and cups in the throttle lower lever.

11. Remove the two screws "P" (Illus. No. 28) and remove the lower lever bracket.

12. Loosen adjusting nut clamp bolt "A" (Illus. No. 24).

13. Turn out adjusting nut "B" (Illus. No. 24).

14. Pull out steering post "C" (Illus. No. 28) with adjusting nut "D", bearing "E" and worm "F".

15. If necessary to remove the worm from the steering post, press it off with an arbor press.

16. Before assembling, oil all parts thoroughly.

17. Reverse operations to assemble.

In assembling, press the worm on the steering post to the center of the keyway. Place the steering post with worm and bearings assembled, in the case and tighten adjusting nut "D" (Illus. No. 28) just enough to remove the end play.

Place washer "H" (Illus. No. 28) in position with the grooved side next to the gear.

Have the cover adjusting screw "R" (Illus. No. 29) turned out as far as possible.

Place ball "I" (Illus. No. 29) in the recess in worm gear "G". This can be held in place with a small amount of cup grease.

Place cover "J" (Illus. No. 29) with gear "G" and washer "H" in case "A", so that lug 'P" is against base "S". Turn worm gear adjusting screw "Q" out several turns and bolt the cover on tight, making sure that lock washers and heavy flat washers are under cover screw heads.

Turn the worm gear adjusting screw in until the end play is just removed from the worm gear shaft. Then tighten the lock nut.

To remove the backlash between the worm and worm gear, loosen the five cover bolts "D" (Illus. No. 24) and turn the cover adjusting screw in until the backlash is eliminated. Then tighten the cover bolts and adjusting screw lock nut. The steering wheel must turn freely after the above adjustments have been made.

18 Fill the steering gear case with very heavy transmission oil through the Alemite fittings.

Tools Required—No. 23, 27 and 29 open end wrenches, adjustable wrench, hammer, screw driver, universal puller C.O. 71, steering post wrench C.O. 405.

ARTICLE No. 24

To Remove and Replace Steering Wheel

1. Disconnect the horn push button cable at the junction block and pull the cable through the clips at the rear end of the engine.

2. Unscrew the horn button (if the car is equipped with this type button) being careful not to lose the coil spring on the inside. In case of the large type button, remove the small set screw in the lighting switch lever hub.

3. Remove the horn button leaving the cable attached. The cable can be pulled out through the top of the steering post.

4. Remove the two screws holding the lighting switch upper lever and remove the lever.

5. Loosen the clamp screw on the lighting switch lever bracket and remove the bracket.

6. Pry the throttle upper lever off of the throttle tube.

7. Remove the steering post nut, using special wrench C. O. 405.

8. Unscrew two of the six screws "D" (Illus. No. 25) opposite each other in the steering wheel hub.

9. Apply the Universal Puller as shown in Illus. No. 25 and pull off the steering wheel. (See C. O. 71, Vol. 8). On metal spoke steering wheels use puller C. O. 132 Illus. No. 26. (Also See Vol. 8).

10. Reverse operations to assemble, making sure that the key is in place in the steering post and that the steering post nut is securely tightened.

Tools Required—Screw driver, pliers steering post nut wrench, C. O. 405, Universal Puller C.O. 71, hammer.

ARTICLE No. 25

To Remove and Replace Steering Post Jacket Bushing

1. Remove the steering wheel. (See Operation Article No. 24).

2. Remove the key from the steering post.

3. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.

4. Take out the two wood screws and remove the small floor board.

5. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.

6. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws

holding the toe board cover to the dash. The toe board can now be removed.

7. If working on an assembly without a steering gear lock, remove the two screws holding the steering post bracket cap and remove the cap. If working on a steering gear with a lock, see Operation Articles No. 31 and 32 to remove the lock.

8. Loosen steering gear bracket clamp bolt "E" (Illus. No. 24) and jacket clamp bolt "C". Drop the steering post enough to pull off the jacket.

9. Drive out the old bushing.

10. Press in the new bushing.

11. Reverse operations to assemble.

Tools Required—Screw driver, hammer, adjustable wrench, pliers, No. 23, 25 and 27 open end wrenches, Universal Puller C. O. 71, steering post nut wrench C. O. 405.

ARTICLE No. 26

To Remove and Replace Throttle Lever and Lighting Switch Lever Tubes

1. Disconnect the horn push button cable at the junction block and pull the cable through the clips at the rear end of the engine.

2. Unscrew the horn button (if the car is equipped with this type button) being careful not to lose the coil spring on the inside. In case of the large type button, remove the small set screw in the lighting switch lever hub.

3. Remove the horn button leaving the cable attached. The cable can be pulled out through the top of the steering post.

4. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.

5. Take out the two wood screws and remove the small floor board.

6. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.

7. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.

8. If working on an assembly without a steering gear lock, remove the two clamp screws holding the steering post bracket cap and remove the cap.

If working on a steering gear with a lock, see Operation Articles No. 31 and 32 to remove the lock.

9. Loosen steering gear bracket clamp bolt "E" (Illus. No. 24), if not already done in operation 8 and drop the steering post enough so that the tubes will clear the top when being pulled out.

10. Loosen the clamp screws holding the lighting switch and the gear at lower end of switch and remove the lighting switch and the gear. Leave the switch lying in the side pan with the wiring connected.

11. Loosen the gear clamp screw at the lower end of the lighting switch tube and pry off the gear.

12. Pull out both tubes.

13. If necessary to remove the upper levers, first take out the two screws holding the lighting switch lever and remove the lever. Then loosen the clamp screw on the lighting switch lever bracket and remove the bracket. The throttle lever can be removed from the tube by tapping it lightly with a small hammer.

14. Reverse operations to assemble.

The throttle lever should be assembled so that the throttle will be closed when the lever is down.

Before replacing the switch, pull the lighting switch lever, on the steering wheel, down so that the word "curb" on the lever hub is at the top. Turn the shaft on the lighting switch clockwise (viewed from the top) as far as possible. Put the switch in place with the conduit hole to the inside and with the gear on the lower end of the shaft turned clockwise so as to engage the last tooth with the corresponding tooth of the gear on the lighting switch lever tube.

Tools Required—Screw driver, pliers, No. 23, 25 and 27 open end wrenches, hammer.

ARTICLE No. 27

To Remove and Replace Lighting Switch

1. Remove the thumb screw and take off the lighting switch cover.

2. Remove the screws holding the cable terminals to the lighting switch and remove the cables and conduit. On cars which have the dimmer resistance unit mounted on the instrument board it will also be necessary to disconnect the two wires leading to it.

3. Loosen the clamp screws holding the lighting switch and the gear at the lower end of the switch and remove the lighting switch and gear.

4. Reverse operations to replace.

Before replacing the switch, pull the lighting switch lever on the steering wheel clear down so that the word "curb" on the lever hub is at the top. Turn the shaft on the lighting switch clockwise (viewed from the top) as far as possible. Put the switch in place with the conduit hole to the inside and with the gear on the lower end of the shaft turned clockwise so as to engage the last tooth with the corresponding tooth of the gear on the lighting switch lever tube.

Then complete operations 3, 2, and 1.

Tools Required—No. 23 and 25 open end wrenches, screw driver.

ARTICLE No. 28

To Take Up End Play in Steering Post

1. Jack up the front axle so that the wheels are clear of the floor.
2. Loosen steering gear case clamp bolt "A" (Illus. No. 24).
3. Loosen steering post jacket clamp bolt "C" (Illus. No. 24).
4. Screw the worm adjusting nut down until the end play in the steering post is just removed. Use care not to get the nut turned down tight enough to cause hard steering. The steering wheel should now turn the front wheels freely.
5. Tighten steering gear case clamp bolt "A".
6. Tighten steering post jacket clamp bolt "C".
7. Remove the jack under the front axle.

Tools Required—Adjustable wrench, No. 25 open end wrench, jack.

ARTICLE No. 29

To Remove End Play in Steering Worm Gear

1. Jack up the front axle so that the wheels are clear of the floor.
2. Loosen the lock nut on worm gear adjusting screw "Q" (Illus. No. 29).
3. Turn the adjusting screw in until the end play is just removed. This can be determined by placing the hand on the worm gear shaft where the steering arm fastens on, while having some one move the steering wheel back and forth slightly. The end play is eliminated when the worm gear shaft cannot be felt to move endwise. Do not turn the screw too tight as this would cause hard steering. The steering wheel should turn freely after the adjustment is made.
4. Tighten the adjusting screw lock nut, being careful not to disturb the adjusting screw.
5. Remove the jack under the front axle.

Tools Required—No. 25 and 29 open wrenches, jack.

ARTICLE No. 30

To Eliminate Backlash Between Worm and Worm Gear

1. Jack up the front axle so that the wheels are clear of the floor.
2. If the backlash is no greater with the front wheels pointing straight ahead than when cramped to one side skip to operation No. 6.

If the backlash is considerably greater with the

front wheels pointing straight ahead than when cramped to one side, this indicates wear on the teeth inasmuch as the gears are used in the straight ahead position more than any other. Proceed with operation No. 3.

3. Remove steering arm nut "A" (Illus. No. 21).

4. Pull off steering arm "C" using steering arm puller C. O. 412. (See Vol. 8).

5. Turn the steering wheel until the worm gear shaft has turned one-half revolution and replace the steering arm on the worm gear shaft.

This will allow different teeth to be in mesh and eliminate play due to worn teeth.

6. Loosen the five steering gear cover bolts "D" (Illus. No. 24).

7. Loosen steering gear bracket clamp bolt "E" (Illus. No. 24).

8. Loosen the cover adjusting screw lock nut and turn adjusting screw "F" in until the remaining backlash has been eliminated. Turn the adjusting screw as far as possible without bringing the worm so close to the gear as to cause hard steering. This will allow elimination of practically all backlash between the gears and still permit free steering.

9. Tighten the five cover bolts, the cover adjusting screw lock nut and the steering gear bracket clamp bolt.

The steering wheel should turn freely after the adjustment is made.

10. Remove the jack under the front axle.

Tools Required—Large and small screw driver, No. 25, 27 and 33 open end wrenches, pliers, hammer, steering arm puller C. O. 412, adjustable wrench, jack.

ARTICLE No. 31

To Remove and Replace Steering Gear Lock

See also Operation Article No. 32.

1. Disconnect the horn push button cable at the junction block and pull the cable through the clips at the rear end of the engine.

2. Unscrew the horn push button (if the car is equipped with this type button) being careful not to lose the coil spring on the inside. In case of the large type button, remove the small set screw in the lighting switch lever hub.

3. Remove the horn button leaving the cable attached. The cable can be pulled out through the top of the steering post.

4. Remove the two screws holding the lighting switch upper lever and remove the lever.

5. Loosen the clamp screw on the lighting switch lever bracket and remove the bracket.

6. Pry the throttle upper lever off of the throttle tube.

7. Remove the steering post nut, using wrench C. O. 405.

8. Unscrew two of the six screws "D" (Illus. No. 25) opposite each other in the steering wheel hub.

9. Apply the Universal Puller as shown in Illus. No. 25 and pull off the steering wheel. (See C. O. 71, Vol. 8). On metal spoke steering wheels use puller C. O. 132, Illus. No. 26. (See Vol. 8).

10. Remove the two screws holding the steering post bracket to the instrument board.

11. Disconnect the two ignition wires at the steering gear lock and loosen clamp screw "D" (Illus. No. 34). With the steering gear unlocked, slide the bracket down on the steering post jacket so that the stud "A" will be removed from the hole in the instrument board.

12. Turn the bracket sideways and slide it off of the steering post jacket.

13. Reverse operations to replace.

Tools Required—Screw driver, hammer, adjustable wrench, pliers, No. 23 and 25 wrench open end wrenches, Universal Puller C. O. 71, steering post nut wrench C. O. 405.

ARTICLE No. 32

To Remove and Replace Steering Gear Lock

The following operations are to be used only when removing the steering lock which has the plunger guide bushing and started with serial numbers:

ARTICLE NO. 32-1

To Remove and Replace Steering Gear Lock

The following revision in Article No. 32 applies to Big Six cars having type of lock operated both ways by key.

1. Disconnect the horn push button cable at the horn and pull the cable through the clips at the front of the engine.
2. Remove the small screw in the lighting switch lever hub.
3. Remove the horn button and coil spring and pull the cable out through the top of the steering post.
4. Remove the two screws holding the lighting switch upper lever and remove the lever.
5. Loosen the clamp screw on the lighting switch lever bracket and remove the bracket.
6. Pry the throttle upper lever off of the throttle tube.
7. Remove the steering post nut, using wrench C. O. 405.
8. Apply puller C. O. 132 as shown in Illus. No. 26, and pull off the steering wheel.
9. Disconnect the two ignition wires at the steering gear lock.
10. With a small cape chisel and hammer tap the break off screw, which holds the right side of the lock to the bracket, until the screw is loosened and can be grasped with a pair of pliers and turned out.
11. Remove the pinch bolt in the other side of the bracket.
12. The steering lock can now be removed by sliding it up the steering post.
13. Reverse operations to replace, using a new break off screw. Turn the screw up tight at the time of assembling the parts, but do not break off the small head until the repairs have passed the final inspection.

Tools Required—Screw driver, cape chisel, hammer, adjustable wrench, pliers, No. 23 and 25 open end wrenches, puller C. O. 132, steering post nut wrench C. O. 405.

Issued August 1, 1927
Insert in Volume One, Big Six Section, after page 74.
PRINTED IN U. S. A.

Big Six	2082544
Special Six	3168510

This type can also be distinguished by the presence of the number in raised figures at point "Q" (Illus. No. 34).

See Operation Article No. 31 for instructions on previous type.

1. Remove the steering wheel. (See Operation Article No. 24).
2. Remove the ignition wires from the lock, tying them out of the way to prevent short circuits and remove the two bolts holding the lock bracket to the instrument board.
3. Remove clamp screw "D" (Illus. No. 34) and spread the lock forging with a cape chisel or drift to effectively loosen it.
4. Remove the bolt "C" (Illus. No. 24) from the clamp which holds the lower end of the steering post jacket to the steering gear adjusting nut. Spread the clamp with a cape chisel or drift.
5. Rotating the steering post jacket slightly in either direction, force it down on the steering gear adjusting nut at least ¼ inch. This must be done before the remaining operations can be performed, in order to expose the lower end of the slot in the jacket.
6. Insert a .005 inch steel shim, ⅜ inch wide, through the lower end of the slot in the jacket, so it will pass under the bushing. See Illus. No. 27.
7. With the shim in place, push the lock down the jacket, raising the steering column at the same time so the stud "A" (Illus. No. 34) will come out of the instrument board in a straight line without binding. In some cases it may be necessary to tap the lock slightly.

The shim under the bushing causes it to be depressed on meeting the end of the slot and ride up on top of the jacket so that the lock may be pushed clear down past the slot.

8. Rotate the lock a half turn and it can be withdrawn from the steering column, leaving the shim in place so that the bushing will not scratch the enamel on the steering post jacket.
9. Reverse operations to assemble.

When sliding the lock back into position on the steering column, place a metal or cardboard shim under the bushing to protect the enamel on the jacket.

Tools Required—No. 23, 25 and 27 open end wrenches, pliers, screw driver, cape chisel, hammer, .005 inch shim stock.

ARTICLE No. 33

To Install Steering Gear Lock on Cars not so Equipped

1. Remove the steering wheel. (See Operation Article No. 24).
2. Remove the key from the steering post.
3. Take out the screws holding the toe plate in the upper corner of the toe board and remove the plate.
4. Take out the two wood screws and remove the small floor board.
5. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.
6. Remove the two large screws at side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The board can now be removed.
7. Remove the two screws, holding the steering post bracket cap, and remove the cap.
8. Remove the two screws holding the bracket to the instrument board and remove the bracket.
9. Loosen steering gear bracket clamp bolt "E" (Illus. No. 24) and jacket clamp bolt "C". Drop the steering post enough to pull off the jacket.
10. Cut a slot 1 inch long and ⅝ inch wide in the jacket at the point shown in Illus. No. 31.

Care must be taken to see that the center line of the slot coincides with the center line of the small oil hole at the top of the jacket. This is necessary because both the slot and oil hole must be on top when the jacket is assembled.

11. Drop the steering post down to a convenient position and locate the two set screw holes on the tube as shown in Illus. No. 32. Drill ¼ inch holes at these points. Do not drill all the

way through the steering tube wall as there is danger of metal chips working down and cutting the babbitt bushings for the lighting switch and throttle tubes. The drill should be stopped just as it starts to break through the tube wall. It will be necessary to file off the pilot end of the set screws so that tht heads will be flush with the surface of the sleeve when assembled.

These set screw holes must be drilled in line with the steering wheel Woodruff keyway in the upper end of the tube.

12. Place the slotted sleeve over the steering tube and install the set screws. See that the heads of the set screws are flush as mentioned in operation No. 11. With a chisel, stake the sleeve into the slots of the set screws to prevent them from turning. (See Illus. No. 33).

13. Reassemble the steering post jacket and tighten clamp bolt "C" (Illus. No. 24), making sure that the slot and oil hole in the jacket are on the upper side.

14. Remove the stud from the upper end of the new steering post bracket containing the lock.

15. Hold the bracket in position on the inner side of the instrument board with the fastening screw holes lined up and spot the position of the stud. Then replace the stud in the bracket.

16. Drill a 9-16 inch hole, 5/8 inch deep at the point marked on the instrument board.

17. When installing the steering gear lock, install also the following parts, which include the heavier type monogram plate and fastening screws:

1 Monogram plate	Part No. 214637
2 Cap screws	Part No. 13x242
2 Lock washers	Part No. 40x103
2 Plain washers	Part No. 41x22

It will be necessary to ream out the two fastening screw holes in the instrument board to 21/32 inch to fit the new monogram plate.

18. With the lock released, slide the bracket over the steering post jack. If the lock is of the type equipped with a plunger bushing at "O" (Illus. No. 34), it will be necessary to insert a metal shim or piece of cardboard between the lock and the steering post jacket during this operation to prevent scratching the enamel on the jacket.

Then raise the steering column up so that the bracket may be applied to the instrument board and fastened.

19. Tighten the clamp screw which holds the bracket to the steering post jacket.

20. Tighten the steering gear to frame bracket clamp bolt "E" (Illus. No. 24).

21. Disconnect the ammeter to ignition switch wire at the ignition switch and connect it to the right-hand terminal of the steering gear lock.

22. Connect one terminal of the new cable assembly (Part No. 45497) to the remaining terminal of the ignition switch and the other end of the cable to the remaining terminal of the steering gear lock.

This completes the wiring circuit and with the steering gear unlocked, and the auxiliary switch turned with the letter "I" in the horizontal position the engine may be started.

23. Reassemble the steering wheel, lighting switch and throttle levers, horn button and toe boards by reversing operations 1 to 9 inclusive.

Tools Required—Screw driver, hammer, adjustable wrench, pliers, No. 23, 25 and 27 open end wrenches, Universal puller C.O. 71, steering post nut wrench C.O. 405, chisel, 1/4 inch drill, 9/16 inch drill.

ARTICLE No. 34

To Raise or Lower Steering Gear on Cars Equipped with Transmission Lock

1. Remove the screws holding the toe plate in the upper left hand corner and remove the plate.

2. Remove the two steering post bracket cap screws and remove the cap.

3. Loosen the steering gear to frame bracket clamp bolt "E" (Illus. No. 24).

4. Remove the two bolts holding the steering post bracket to the instrument board and remove the bracket.

5. If the steering post is to be lowered, install steering post bracket part No. 214896 in place of the bracket that has been removed.

6. If the steering post is to be raised, drill two holes in the steering post bracket (where the bracket fastens to the instrument board). These holes must be drilled on a line with the original holes but lower down on the bracket, this amount to be determined by the amount the steering post is to be raised.

7. Reverse operations to assemble.

When assembling the toe plate it will be necessary to file out the hole enough to clear the steering post jacket.

Tools Required—Pliers, screw driver, No. 25, 27 and 29 open end wrenches, file, hammer.

ARTICLE No. 35

To Raise or Lower Steering Gear on Cars Equipped with Steering Gear Lock

1. Remove the steering wheel. (See Operation Article No. 24).
2. Remove the key from the steering post.
3. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.
4. Take out the two wood screws and remove the small floor board.
5. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.
6. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.
7. Loosen the steering gear to frame bracket clamp bolt nut "E" (Illus. No. 24).
8. Remove the two screws holding the steering lock bracket to the instrument board and loosen the bracket clamp screw. Slide the bracket down until the stud is removed from the hole in the instrument board.

Note—If the lock is of the type equipped with a plunger bushing it must be lowered as described in Operation Article No. 32, operations 3 to 8 inclusive.

9. Disconnect the two ignition wires at the lock and with the lock released, slide the assembly off of the steering post jacket.
10. To lower steering post drill two new fastening holes in the lock bracket above the original holes. (The post can be lowered approximately 1¼ inches if desired). Drill the new holes on a line with original holes, the distance above to be determined by the amount the steering gear is to be lowered. If the two extra holes are already drilled in the bracket this operation can be omitted.
11. Unscrew the stud from the lock bracket.
12. Hold the bracket in position on the inner side of the instrument board with the new fastening screw holes in the bracket lined up with the holes in the instrument board and spot the position of the stud. Then replace the stud in the bracket.
13. Drill a 9/16 inch hole, ⅝ inch deep at the point marked on the instrument board.
14. When lowering the steering gear on cars having the steering gear bracket fastened to the instrument board with carriage bolts, this assembly should be changed. The carriage bolts should be left out and the later type monogram plate used. In this case the following parts will be required:

1 Monogram plate	Part No. 214637
2 Cap screws	Part No. 13x242
2 Lock washers	Part No. 40x103
2 Plain washers	Part No. 41x22

Ream out the fastening screw holes in the instrument board to 21/32 inch to fit the new monogram plate, if this is being installed.

15. Slide the lock bracket into position on the steering post jacket and fasten the bracket to the instrument board.

It may be found after lowering the steering post that the lock plunger does not line up with the slot in the jacket making it either impossible to lock the steering or possible to open the lock by pushing up the plunger through the exposed slot.

16. In this case loosen the steering post jacket clamp bolt and turn the jacket 180 degrees.
17. Mark the position of the lock on the jacket.
18. Remove the lock and jacket from the car. (See Operation Article No. 25).
19. Cut a slot 1 inch long and ⅝ inch wide in the jacket at the point marked. Another oil hole must also be drilled in the upper end of the jacket 180 degrees from the original hole.
20. If, after completing the above operations, it is found that an objectionabe amount of the lock bracket extends below the instrument board, this can be cut away with a hack saw and finished off with a file.

The above operations will also apply to raising the steering post except that the new fastening holes must be drilled below the original holes instead of above.

Care must be taken not to raise the steering post too high, as clearance must be allowed at the instrument board for free operations of the lock lever.

21. Reverse operations to assemble.

When assembling the toe plate it will be necessary to file out the hole enough to clear the steering post jacket.

Tools Required—Screw driver, hammer, adjustable wrench, pliers, No. 23, 25 and 27 open end wrenches, Universal Puller C.O. 71, steering post nut wrench, C.O. 405, chisel 9/16 and 3/8 inch drills.

ARTICLE No. 36

To Remove and Replace Spring Shackle Bolts

1. If no chain hoist is available jack up the car and block under the frame as shown in Illus. No. 35, taking the load off of the spring from which the bolts are to be removed.

2. Remove the cotter pin and nut from the bolt to be removed.

3. Drive out the bolt.

4. Reverse operations to reassemble.

In reassembling the spring bolts, screw the nuts on tight and then back them off about two notches before inserting the cotter pin.

Caution—Be sure these nuts are not left tight or a broken spring or frame may result.

Tools Required—Jack, blocking, No. 31 and No. 33 open end wrenches, pliers and hammer.

ARTICLE No. 37

To Install New Spring and Spring Hanger Bushings

1. If no chain hoist is available jack up the car and block under the frame as shown in Illus. No. 35, taking the load off of the spring where bushings are to be installed.

2. Remove the cotter pins and nuts from the spring and spring hanger bolts.

If replacing the rear spring front bushing it is advisable to remove the spring. (See Operation Article No. 39).

3. Unscrew the nuts and drive out the bolts.

4. Drive out the old bushings with a drift and hammer.

5. Drive in the new bushings using a hard wood block and hammer.

6. Ream out the bushings. (See Vol. 8, C.O. 200).

7. Reverse operations to assemble.

In assembling the spring bolts screw the nuts on tight and then back them off about two notches before inserting the cotter pin.

Caution—Be sure these nuts are not left tight or a broken spring or frame may result.

Tools Required—Jack, suitable blocking, pliers, drift, hammer, No. 31 and 33 open end wrenches, hardwood block, bushing reamers.

ARTICLE No. 38

To Remove and Replace Front Spring

1. Remove nuts "C" (Illus. No. 17) from the main clips holding the axle to the front spring.

2. Block up the frame (on the side of the car from which the spring is to be removed) until the spring is clear of the axle. (Block the frame as shown in Illus. No. 35, or use a chain hoist, lifting the frame by the front frame horns).

3. Remove the two cotter pins and two nuts at the rear shackle.

4. Drive out the two spring bolts.

5. Remove the front bolt cotter pin and nut.
6. Drive out the bolt.
7. The spring can now be removed.
8. Reverse operations to assemble.

When replacing the spring main clips and nuts see that a good heavy wrench is used so that the nuts can be drawn as tight as possible. Install the spring seat with the large end toward the front.

See that the spring center bolt is in the hole in the spring seat. In re-assembling the spring bolts, screw the nuts on tight and then back them off about two notches before inserting the cotter pin.

Caution—Be sure these nuts are not left tight or a broken spring or frame may result.

Tools Required—Jack, blocking, No. 31 and 33 open end wrenches, pliers, adjustable wrench, drift and hammer.

ARTICLE No. 39

To Remove and Replace Rear Spring

1. Jack up the side of the car from which the spring is to be removed, until the wheel just clears the ground.
2. Place suitable blocking under the frame just ahead of the rear spring front hanger to hold the frame in this position. Block the front wheels to prevent the car from rolling off the blocking.

(If a chain hoist is available hook under the frame rear horns and raise the frame until the weight is taken off of the springs).

3. Remove the nuts from the spring clips that hold the axle to the spring.
4. Drive off the spring plate under the spring.
5. Remove the cotter pin and nut from the rear lower spring shackle bolt.
6. Drive out the bolt allowing the rear end of the spring to drop.
7. Remove the cotter pin and nut and drive out the front spring bolt.
8. Reverse operations to assemble.

See that the spring center bolt is in the hole in the spring seat.

When replacing the spring clips and nuts see that a good heavy wrench is used so that the nuts can be drawn as tight as possible.

In assembling the rear shackle bolts screw the nuts up tight and then back them off about two notches before inserting the cotter pin.

Caution—Be sure these nuts are not left tight or a broken spring or frame may result.

Tools Required—Jack, blocking, pliers, drift, hammer, No. 31 and 33 open end wrenches, adjustable wrench.

ARTICLE No. 40

To Remove and Replace Spring Center Bolt

To install the center bolt in a front spring use the following operations:

1. Remove nuts "C" (Illus. No. 17) from main clips holding the spring to the front axle.
2. Remove the clips and upper spring plate.
3. If no chain hoist is available, place a jack under the frame just back of the front spring rear hanger and raise the frame until the spring seat and center bolt can be removed.
4. Install a new center bolt.
5. Reverse operations to assemble.

When assembling see that the large end of the spring seat is toward the front and that the head of the center bolt is in the hole in the spring seat.

To install the center bolt in a rear spring use the following operations:

1. Place the jack under the frame just ahead of the front hanger.
2. Place a "C" clamp on the spring as near the center as possible and screw it up tight.
3. Remove the "U" bolt nuts holding the spring to the axle and remove the spring plate.
4. Remove the cotter pin and nut and drive out the lower rear shackle bolt. Allow the spring to drop down.
5. Remove the center bolt.
6. If the center bolt is broken and the spring leaves have shifted so that the hole does not line

up, unscrew the "C" clamp, line up the leaves and insert a long drift or piece of rod to hold them in place.

7. Clamp the spring together with the "C" clamp and install the new bolt.

8. Remove the "C" clamp and assemble by reversing operations.

See that the spring center bolt head is in the hole in the axle.

When replacing the spring main clips and nuts see that a good heavy wrench is used so that the nuts can be drawn as tight as possible.

In reassembling the spring shackle bolts screw the nuts on tight and then back them off about two notches before inserting the cotter pin.

Caution—Be sure these nuts are not left tight or a broken spring or frame may result.

Tools Required—Jack, blocking, No. 25, 27, 31 and 33 open end wrenches, "C" clamp, long drift, pliers, hammer, rear spring clip wrench C.O. 270.

ARTICLE No. 41

To Remove and Replace Rear Wheel

1. Place a jack under the rear wheel and raise it until the wheel to be removed clears the ground.
2. Unscrew the hub cap.
3. Remove the cotter pin and unscrew axle shaft nut "B" (Illus. No. 37).
4. Remove the wheel with a wheel puller. (Illus. No. 38).
5. Remove the axle shaft key.
6. To replace the wheel, first make sure that the axle shaft and wheel hub are wiped clean, then slide on the wheel.

Drive in the key, flush with the outer face of the hub or far enough to start the nut on the shaft. Then turn the nut on tight with a heavy wrench.

7. Install the cotter pin, using a new one.
8. Turn on the hub cap.
9. Remove the jack under the rear axle.

Tools Required—Hub cap wrench, pliers, wheel puller, axle shaft nut wrench C.O. 275, jack and hammer.

ARTICLE No. 42

To Remove and Replace Rear Axle Shaft

1. Remove the rear wheel. (See Operation Article No. 41).

2. Remove the cotter pin and nut from the axle shaft adjusting nut clamp bolt at "A" Illus. No. 47.

3. Pull out the clamp bolt and remove retainer lock at "H". Illus. No. 47.

4. Unscrew the adjusting nut from the axle housing.

5. Pull out the axle shaft.

6. To re-assemble the axle shaft reverse operations 2 to 5, making sure that the shaft turns freely. It is advisable to allow about .002 inch end play to make sure the shafts do not bind.

After the above adjustments have been made each axle shaft adjusting nut should project from the axle housing the same amount. If they do not, screw out the one which projects the least and screw in the other, until they are equal. This is necessary in order to bring rear wheels in line with the front wheels.

7. To replace the wheel, make sure that the axle shaft and wheel hub are wiped clean, then slide on the wheel. Drive in the key flush with the outer face of the hub or far enough to start the nut on the shaft and then turn the nut on tight with a heavy wrench.

8. Install the cotter pin.
9. Screw on the hub cap.
10. Remove the jack from under the axle.

Tools Required—Jack, hub cap wrench, pliers, wheel puller, axle shaft nut wrench C. O. 275, retainer nut wrench, C.O. 260, hammer and No. 29 open end wrench.

ARTICLE No. 43

To Remove and Replace Rear Axle Shaft Thrust Plugs

1. Remove the rear axle shaft. (See Operation Article No. 43).
2. Grind off the hardened end of the thrust plug on an emery wheel.
3. Drill a ¼ inch hole lengthwise through the plug. In most cases it will be necessary to stop just short of the inner end, due to the hardening, but sometimes the drill will break through. If it does not go clear through, the inner end can be broken out with a punch.

A power drill should be used for this, with a drill of high speed steel. Turpentine will help it through.

4. Fill the hole full of white lead or in the absence of this material, use heavy grease.
5. Put a length of ¼ inch drill rod in the hole and drive with a heavy hammer. More white lead must be added as the plug moves out of the hole and the space behind it is increased.
6. An arbor press should be used in installing the new plug, being very careful not to damage it.

After putting in the new plug, the distance from the inside face of the wheel bearing to the outer end of the plug must be carefully checked to insure its being within the following limits:

Big and Special Six passenger cars	24.838 inch to 24.868 inch
Bus Chassis	24.588 inch to 24.618 inch

Tools Required—Emery wheel, power drill, ¼ inch high speed drill, ¼ inch drill rod, heavy hammer, white lead, arbor press.

ARTICLE No. 44

To Remove and Replace Differential Assembly

1. Remove both rear wheels. (See Operation Article No. 42).
2. Remove both axle shafts. (See Operation Article No. 43).
3. Place a pail under the rear axle to catch the grease from the housing.
4. Remove the cap screws holding the housing cover.
5 Remove the cover and gasket allowing the grease to drain in the pail.
6. Pull the cotter pins or locking wires and remove the four nuts or screws "A" (Illus. No. 44).
7. Pull off the two differential bearing caps "B" (Illus. No. 44).
8. Lift out the differential assembly.
9. Reverse operations to assemble.

Set the differential assembly in place but do not tighten the clamp nuts or put in the cotter pins until the adjustments are made.

With considerable backlash between the pinion and ring gear adjust the differential bearings for side play by drawing retainers "C" tight (Illus. No. 44) and then backing off two or three notches, or so that the differential turns freely, but has no side play. (Retainers can be turned with a screw driver or spanner wrench).

Then adjust the backlash between the ring gear and pinion (.005 to .008 of an inch) by loosening one retainer and tightening the other the same amount (by so doing the bearing adjustment is not disturbed) depending on which way the ring gear is to be moved. Then tighten the differential clamp nuts or screws but do not install the cotter pins or locking wires. Try the gears for backlash again as tightening the clamp nuts will sometimes change the adjustment. When the proper adjustment is obtained drive retainer locks "D" (Illus. No. 44) into the slots in the retainers and install the cotter pins or locking wires.

Remove the filler plug and fill the housing to the height of the filler plug hole. Use a very heavy transmission oil or light transmission grease in warm weather. In extremely cold weather 25 per cent of this should be replaced with heavy engine oil.

Tools Required—Jack, hub car wrench, pliers, wheel puller, axle shaft nut wrench C.O. 275, retainer nut wrench C.O. 260, No. 25 and 29 open end wrenches, screw driver and hammer.

ARTICLE No. 45

To Disassemble and Assemble Differential

1. Remove the four differential case screw lock wires and the eight screws "I", (Illus No. 44).

2. Separate the two halves of the differential case "E" (Illus. No. 44).

3. The cross "A", pinions "B" and side bevel gears "C" (Illus. No. 45) can now be removed.

4. Pull the cotter pins and remove the nuts from bolts "D" (Illus. No. 45) holding the ring gear to the case.

5. Remove the bolts and the ring gear.

6. The bearings "E" on either half of the case are pressed on. To remove them use a chisel and drive between the bearing and the case to start them. Then use the puller C.O. 132 with the boss C.O. 71-3, Vol. 8. (This is only necessary in case of replacing the bearings).

7. Reverse operations to re-assemble the differential, making sure that the two halves of the case are put together so that the numbers, or marks, on both halves (Illus. No. 44) are directly opposite and that the two surfaces are perfectly clean. These precautions are necessary in order to prevent the differential case from running out of true.

Tools Required—No. 25, 27 and 29 open end wrenches, screw driver, chisel, punch, pliers and hammer.

ARTICLE No. 46

To Remove and Replace Rear Axle Pinion Assembly

1. Remove the bolts from the rear universal joint and drop the rear end of the propeller shaft.

2. Remove the clamp bolt and lock "A" (Illus. No. 39).

3. Unscrew nut "C" (Illus. No. 39) and remove the pinion assembly.

4. Reverse operations to assemble.

When replacing, screw the pinion assembly into the differential carrier until the heels or large ends of the pinion and ring gear teeth are flush. It will be necessary to remove the housing cover to observe the position of the gears. For further adjustment, see Operation Article No. 49.

Tools Required—No. 25 and 29 open end wrenches, pliers, hammer, adjustable wrench, spanner wrench.

ARTICLE No. 47

To Disassemble and Assemble Rear Axle Pinion Assembly

1. Remove cotter pin and nut "K" and pull off the flange "J" (Illus. No. 40) using Universal Puller C.O. 71 (See Vol. 8).

2. Remove the flange key from the pinion shaft.

3. Remove the clamp bolt and lock from adjuster "I" (Illus. No. 41). The adjuster can then be unscrewed from the flange.

4. With a lead hammer, pinion "A" and bearing "B" can now be driven from the assembly.

5. Unscrew nut "G" and remove retainer "E" and bearing "D".

6. To remove bearing "B" from pinion "A" (Illus. No. 41) use Rear Axle and Transmission Pinion Bearing Puller C.O. 132 (See Vol 8).

7. Reverse operations to assemble.

After the pinion and bearings are in place, assemble the felt washers and retainers "E" and "G" (Illus. No. 42) on adjuster "I" as shown. Retainer "E" should be installed with the cupped side toward bearing "D" as shown in Illus. No. 41. Then slip this assembly into carrier "C" and screw in retainer "G". This order of assembly is essential in order that the felt will not be pinched between the end of the adjuster "I" and the bearing "D" (Illus. No. 42).

Then screw flange "J" into adjuster "I" (Illus. No. 41). The adjuster should be screwed far enough on the flange that it will not touch the bearing and prevent the flange from being drawn up tight.

ARTICLE NO. 43-1

To Remove and Replace Rear Axle Shaft Thrust Plugs

The following addition to Article No. 43 describes another way of performing the same operation.

1. Remove the rear axle shaft. (See Operation Article No. 42).

2. Place the axle shaft in a vise and wrap the splined end with a damp cloth or damp asbestos.

3. Now weld a piece of ⅜ of an inch round steel stock to the end of the thrust plug in the axle shaft. Allow the axle and weld to cool slowly. *Do not chill or cool rapidly.*

4. When cool the piece of steel stock welded onto the thrust plug should be gripped up close in the vise and then drive on the end of the axle with a brass drift or lead hammer. A few blows should release the plug from the axle shaft.

5. An arbor press should be used in installing the new plug, being very careful not to damage it.

After putting in the new plug, the distance from the inside face of the wheel bearing to the outer end of the plug must be carefully checked to insure its being within the following limits:

Big and Special Six passenger cars

24.838 inches to 24.868 inches

Bus Chassis

24.588 inches to 24.618 inches

Tools Required—Welding Outfit, ⅜ inch steel stock, brass drift, hammer and arbor press.

Issued August 1, 1927
Insert in Volume One, Big Six Section, after page 82.
PRINTED IN U. S. A.

After the flange is in place drive in the key and put on the nut "K" (Illus. No. 40).

To adjust the bearings, hold the flange "J" (Illus. No. 43) and turn the adjuster "G" clockwise (looking at the assembly from the front or flange end) until tight. Then back off about one-half turn or until bearings are free but have no end play. Then put key and clamp bolt in adjuster "G".

Turn the oil retainer "D" (Illus. No. 43) in until the felt is under sufficient tension to retain the oil.

To replace the assembly in the carrier, see Operation Article No. 46.

Tools Required—No. 25 and 29 open end wrenches, pliers, hammer, adjustable wrench, spanner wrench, puller C.O. 71, puller C.O. 132.

ARTICLE No. 48

To Remove and Replace Differential and Carrier Assembly

1. Remove the rear wheels. (See Operation Article No. 41).
2. Remove the axle shafts. (See Operation Article No. 42).
3. Remove the bolts from the rear universal joint and drop the rear end of the propeller shaft.
4. Place a pail under the center of the axle housing to catch the grease from the housing.
5. Remove the ten bolts holding the differential carrier to the housing.
6. The differential carrier and pinion assembly can now be removed.
7. Reverse operations to assemble.

Remove the filler plug and fill the housing to the height of the filler plug hole. Use a very heavy transmission oil or light transmission grease in warm weather. In extremely cold weather 25 per cent of this should be replaced with heavy engine oil.

Tools Required—Jack, hub car wrench, pliers, wheel puller, axle shaft nut wrench C.O. 275, retainer nut wrench C.O. 260, No. 25 and 29 open end wrenches, screw driver and hammer.

ARTICLE No. 49

To Disassemble and Assemble Rear Axle Pinion and Differential Assembly Including Adjustment of Bearings and Gears

1. Remove the differential and carrier assembly from the car (See Operation Article No. 48) and place it in a rear axle stand or vise.
2. Pull the cotter pins or lock wires and remove the four nuts or screws "A" (Illus. No. 44).
3. Pull off the two differential bearing caps "B" (Illus. No. 44).
4. Lift out the differential assembly.
5. Remove the four differential case wires and eight screws "I", (Illus. No. 44).
6. Separate the two halves of differential case "E" (Illus. No. 44).
7. Cross "A" pinions "B" and side bevel gears "C" can now be removed.
8. Pull the cotter pins and remove nuts from bolts "D" (Illus. No. 45), holding the ring gear to the case.
9. Remove the bolts and the ring gear.
10. The bearings "E" on either half of case are pressed on the case. To remove, use a chisel and drive between bearing and case to start. Then use the puller C.O. 132 with the boss C.O. 71-3. See Illus. in Vol. 8. (This is only necessary in case of replacing bearings).
11. Remove the clamp bolt and lock "A" (Illus. No. 39).
12. Unscrew nut "C" (Illus. No. 40) and remove the pinion assembly.
13. Remove the cotter pin and nut "K" and pull off flange "J" (Illus. No. 39) using the Universal Puller. (See C.O. 71- Vol. 8).
14. Remove the flange key from the pinion shaft.
15. Remove the clamp bolt and lock from adjuster "I" (Illus. No. 41). The adjuster can then be unscrewed from the flange.
16. With a lead hammer, pinion "A" and bearing "B" can now be driven from the assembly.

17. Unscrew nut "G" and remove retainer "E" and bearing "D".

18. To remove bearing "B" from pinion "A" (Illus. No. 41) use puller C.O. 132. (See Vol. 8).

19. Re-assemble the differential assembly by reversing operations 2 to 10.

20. Adjust the differential bearings by screwing in on retainers "C" (Illus. No. 44) the same amount on both sides until the bearings are tight and the differential assembly will not turn freely. Then back off two or three notches or until the assembly turns freely in the bearings but has no side play. Do not tighten the four cap nuts "A" until all adjustments have been made.

21. Re-assemble the drive pinion and bearings by reversing operations 13 to 18.

After the pinion and bearings are in place. assemble the felt washers and retainers "E" and "G" (Illus. No. 42) on adjuster "I" as shown. Retainer "E" should be installed with the cupped side toward bearing "D" as shown in Illus. No. 41. Then slip this assembly into carrier "C" and screw in retainer "G". This order of assembling is essential in order that the felt will not be pinched between the end of the adjuster "I" and the bearing "D" (Illus. No. 42).

Then screw flange "J" into adjuster "I" (Illus. No. 41). The adjuster should be screwed far enough on to the flange that it will not touch the bearing and prevent the flange from being drawn up tight.

After the flange is in place drive in the key and put on the nut "K" (Illus. No. 40).

To adjust the bearings, hold the flange "J" (Illus. No. 43) and turn the adjuster "G" clockwise (looking at the assembly from the front or flange end) until tight. Then back it off about one-half turn or until the bearings are free but have no end play. Put the key and clamp bolt in adjuster "G".

Turn the oil retainer "D" (Illus. No. 43) in until the felt is under sufficient tension to retain the oil.

Drive pinion assembly is now ready to screw into the differential carrier.

22. Screw the pinion assembly into the differential carrier until the heels or large ends of the pinion and ring gear teeth are flush. Be sure to have plenty of backlash between the ring gear and pinion teeth (.015 inch to .020 inch) while making this adjustment.

Then adjust the backlash between the ring gear and pinion to .005 to .008 of an inch, by loosening one retainer "C" (Illus. No. 44) and tightening the other the same amount (by so doing the bearing adjustment is not disturbed) depending on which way the ring gear is to be moved.

Tighten the four cap screws and test the backlash again as this will sometimes change the adjustment.

23. After completing the above adjustment, paint 10 or 15 ring gear teeth with a light coat of red lead or Prussian blue. Rotate the rear axle pinion several turns in each direction at the same time putting considerable back pressure with the hand on the ring gear. The bearing impression obtained in this way should approach as near as possible that shown in Illus. No. 46, Fig. 2. New gears, however, will usually appear more as a toe bearing (Fig. 3). To move this bearing toward the heel, move the ring gear away from the pinion, giving more backlash. In no case, however, allow the bearing to leave the toe completely.

If the bearing appears as in Fig. 4, it can be moved toward the toe by moving the ring gear in toward the pinion, giving less backlash.

If the bearing is too low, as in Fig. 5, it can be corrected by moving the pinion away from the ring gear.

If the bearing is too high, as in Fig. 6, it can be corrected by moving the pinion in toward the ring gear.

24. After the proper adjustment is obtained, drive the retainer locks "D" (Illus. No. 44) into the slot in the retainers, tighten the retainer clamp screw nuts and install four cotter pins or lock wires.

If, after carrier assembly is placed in car, it is found to be noisy on the drive, remove pinion adjustment retainer lock "A" (Illus. No. 40) and unscrew (turn counter clockwise facing the rear of the car) adjusting nut "C" a notch or two until satisfactory adjustment is obtained.

If noisy on the coast proceed as above except turn adjusting nut clockwise (or in) until satisfactory adjustment is obtained.

Tools Required—No. 25, 27 and 29 open end wrenches, large screw driver, chisel, hammer, pliers, spanner wrench, Universal puller C.O. 71 and C.O. 132 puller.

ARTICLE No. 50

To Remove and Replace Rear Axle Assembly and Wheels Complete

1. Take out the six bolts holding the rear universal joint to rear axle drive flange.
2. Disconnect the snubbers or rebound straps. Before disconnecting the snubber straps from the axle housing, drive a nail into the strap at the point where it enters the snubber housing in such a manner that it will prevent the strap from springing back into the housing, thus eliminating the necessity of adjusting the snubber when reassembling.
3. If no chain hoist is available, jack up the car and place suitable blocking under the frame just ahead of both rear spring front hangers so that the wheels just clear the floor. Block the front wheels to keep the car from rolling.
4. Remove the nuts from the spring clips that hold the rear axle to the springs, and knock off the spring plates.
5. Pull the cotter pins and drive out the two clevis pins connecting the brake rods to the brake bell cranks.
6. Pull the cotter pins and remove the nuts from the lower shackle bolts at the rear end of each spring.
7. Drive out the two shackle bolts allowing the rear ends of both springs to drop down.
8. The rear axle and wheels assembly can now be rolled out from under the car. If the car is not held by a chain hoist so it can be raised, it will be necessary to remove one wheel in order to pull the axle from underneath the car. This is necessary in order to clear the fenders.
9. Reverse operations to assemble, making sure that the spring center bolts are in the holes in the axle housing spring pads.

Tools Required—Jack, blocking, pliers, drift, hammer, No. 25, 31 and 33 open end wrenches.

ARTICLE No. 51

To Remove and Replace Rear Wheel Hub

(Wood Wheel Equipment)

1. Remove the rear wheel. (See Operation Article No. 41).
2. File off the peened ends of the 12 hub bolts.
3. Remove nuts from the hub bolts and drive out the bolts.
4. Remove the brake drum and press out the wheel hub.
5. Reverse operations to assemble, making sure to use new bolts and nuts. Peen over the ends of the bolts after tightening.

Tools Required—Jack, hub cap wrench, pliers, wheel puller, axle shaft nut wrench, C.O. 275, file, hammer, drift and No. 27 open end wrench.

ARTICLE No. 52

To Drain, Flush and Refill Rear Axle

1. Place a pail under the center of the axle housing to catch the grease.
2. Remove the ten bolts holding the axle housing cover and remove the cover.
3. Wash the gears and inside of the axle housing thoroughly with gasoline.
4. Make sure that all gasoline is removed from the inside of the housing, then replace the cover.
5. Remove the filler plug and fill the housing to the height of the filler plug hole. Use a very heavy transmission oil or light transmission grease in warm weather. In extremely cold weather replace 25 per cent of this with heavy engine oil.

Tools Required—Pliers, No. 25 wrench, pail, brush.

ARTICLE No. 53

To Install New Rear Axle Housing

1. Remove the rear axle assembly and wheels. (See Operation Article No. 50).

2. Remove both rear wheels. (See Operation Article No. 41).

3. Remove both axle shafts. (See Operation Article No. 42).

4. Remove the differential and carrier assembly. (See Operation Article No. 48).

5. Remove the brake bands. See operation Article No. 34, Vol. 2, or use the following operations:

A. Turn out adjusting screws "E" and "G" (Illus. No. 47).

B. Pull the cotter pin and remove the brake rod clevis pin at the bell crank.

C. Turn off upper adjusting nut "D" (Illus. No. 47) and remove the spring.

D. Slide off the band and the bell crank assembly, holding the hand over the rear bracket at "G" to prevent the two small release springs from flying out.

6. Remove the two Alemite fittings leading to the axle shaft bearings.

7. Remove the two axle housing grease drain pipes.

8. Reverse operations and assemble the parts into the new axle housing.

After the assembly is completed and has been installed in the car, place a jack under the housing and raise until both rear wheels are clear of the floor.

Turn the brake adjusting screw "G" (Illus. No. 47) until the clearance between the brake band lining and the brake drum at this point is .015 of an inch.

Turn the lock nuts "C" to give the same clearance to the lower half of the band. Turning these nuts up loosens the band and turning them down tightens it. After making this adjustment be sure the lower nut is locked against the upper one.

Turn the adjusting screw "E" (Illus. No. 47) to give .015 of an inch clearance.

Turn the adjusting screw "D" (Illus. No. 47) so that the end of upper half of band is free and a clearance of .015 of an inch is maintained around the band. If necessary make a slight readjustment by means of screw "E" to give uniform clearance.

Turn the adjusting clevises on the brake side rods (Illus. No. 47), so that when connected in place any lost motion will be taken out of the bell cranks without disturbing the position of the brake bands.

Check the clearance between the brake band and the drum with a .015 of an inch feeler gauge. The gauge should pass entirely around the drum with a snug fit at all points.

Remove the jacks under the rear axle.

Tools Required—Jacks, blocking, screw driver, pliers, drift hammer, No. 25, 29, 31 and 33 open end wrenches, wheel puller, axle shaft nut wrench C.O. 275, retainer nut wrench C.O. 260, 1/32 feeler gauge.

ARTICLE No. 54

To Remove and Replace Propeller Shaft Assembly

The following operations are to be used when removing the propeller shaft assembly on passenger cars and the rear propeller shaft assembly on the bus chassis.

1. Remove the six universal joint nuts at each end of the propeller shaft and drive out the bolts.

2. Move the front universal joint back on the splines and remove the assembly.

3. Reverse operations to replace.

Tools Required—No. 25 open end wrench, 9/16 inch socket wrench, pliers, hammer.

ARTICLE No. 55

To Remove and Replace Front Propeller Shaft and Bearing Assembly on Bus Chassis

1. Remove the universal joint nuts at each end of the front propeller shaft and drive out the bolts.
2. Move the rear propeller shaft front universal joint back on the splines and allow it to drop down.
3. Remove the four nuts "F" (Illus. No. 48) and remove the propeller shaft assembly.
4. Reverse operations to replace.

Make sure that the dowel "G" is entered in the hole in the frame cross member and tighten the four nuts "F" securely.

Tools Required—No. 25 and 27 open end wrenches, 9/16 inch socket wrench, pliers, hammer, screw driver.

ARTICLE No. 56

To Disassemble Bus Chassis Front Propeller Shaft

See also Operation Article No. 57.

1. Remove the front propeller shaft and bearing assembly. (See Operation Article No. 55).
2. Place the shaft in a vise and remove the cotter pin and nut at "D" (Illus. No. 48).
3. With a small screw driver, pry out the spring wire lock "C" (Illus. No. 49) and slide the bracket toward the front end of the shaft, thus removing it from the bearing. It may be necessary to tap the bracket lightly with a hammer to break it loose from the bearing.
4. Pull the flange and bearing from the shaft with Universal Puller C.O. 71. (See Vol. 8).
5. Straighten the lips of lock washer "H" (Illus. No. 50) and remove nut "J".
6. Slide off the lock washer and remove nut "G".
7. Tap the bearing lightly to remove it from the flange.
8. Reverse operations to assemble.

Tools Required—Screw driver, pliers, hammer, adjustable wrench, 1 7/16 inch socket wrench, Universal Puller C.O. 71.

ARTICLE No. 57

To Disassemble Bus Front Propeller Shaft

The following operations are to be used only when disassembling bus front propeller shaft support bearing which started with serial numbers, Hearse chassis 2088139, 158 *inch Bus* 2088136, 184 *inch Bus* (*Single wheel*) 2086117, 184 *inch Bus.* (*Dual wheel*)2088141. *See Operation Article No.* 57 *for instructions on previous type.*

1. Remove the front propeller shaft and bearing assembly. (See Operation Article No. 55).
2. Place the shaft in a vise and remove the cotter pin and nut at "D" (Illus. No. 55).
3. Remove the three bolts holding the retainer covers "B" and "O" (Illus. No. 57).
4. The flange, bearing and support assembly can now be pulled from the shaft with Universal Puller C.O. 71 (See Vol. 9).
5. Slide the flange "F" (Illus. No. 56) and bearing assembly out of the support housing "H".
6. Grip the edge of the flange "F" (Illus. No. 57) in a vise and remove nut "G" and lock washer "J".
7. Bearing "L", oil washer "N" and cover "O" (Illus. No. 57) can now be removed from the flange.
8. Reverse operations to assemble.

Clean the inside of the support "H" (Illus. No. 57) thoroughly and see that it is free from all burrs.

See that the flange and bearing assembly are placed in the support housing from the side nearest the pin "G" (Illus. No. 55).

Tools Required—Screw driver, pliers, hammer, adujstable wrench, No. 23 open end wrench, 1 7/16 inch socket wrench, Universal Puller C. O. 71.

Revised August 1, 1927
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ARTICLE No. 58

To Remove and Replace Front Universal Joint Assembly

The following operations are to be used when removing the front universal joint on passenger cars and the rear propeller shaft front universal joint on the bus chassis.

1. Remove the six nuts and bolts at the front driving flange.
2. Turn off the brass sleeve "E" (Illus. No. 51).
3. Slide off the front universal assembly.
4. Reverse operations to reassemble, making sure that the arrow or other mark (as shown in Illus. No. 51) on the universal yoke sleeve registers with the same mark on the propeller shaft.

Tools Required—No. 25 open end wrench and pliers.

ARTICLE No. 59

To Remove Universal Joint Cross and Bushings

1. Remove the universal joint or propeller shaft to be worked on and take it to the work bench. (See Operation Articles 54, 55 or 58).
2. Take off the two nuts "G" (Illus. No. 51) on the casing spring retainer.
3. Drive out the two spring retainer clamp bolts and remove the retainer and spring.
4. Slide back the outer casing "H" and the inner casing "D" (Illus. No. 51).
5. Pull out the two bushings (Illus. No. 52) in the flange yoke and remove the flange.
6. Pull out the two locking wires "D" (Illus. No. 52) around the bushings in the propeller shaft yoke. (When reassembling use new wires if possible).
7. Slide out the two bushings and remove the cross as in Illus. No. 53.
8. Reverse operations to assemble.

Lubricate the bushings and cross with engine oil when reassembling.

Be sure to assemble the cross so that the flat surface at "A" is toward the surface "B" of flange (Illus. No. 53).

Pack the joint one-third full of universal joint grease.

When placing the front universal joint in the car be sure to line up the arrow on the universal yoke sleeve with the same mark on the propeller shaft.

Tools Required—No. 25 open end wrench, pliers, screw driver and hammer.

ARTICLE NO. 60

To Disassemble and Assemble Steering Gear Lock
(Type using separate ignition switch)

1. Remove the lock assembly from the car. (See Operation Article No. 31 or 32).
2. Remove the two screws "G" and stud "A" and remove the aluminum cover plate "B" (Illus. No. 30).
3. Remove the ignition switch retaining screw and wire "H" and remove the switch.
4. Drill out the lock cylinder retaining pin located on the top of the cylinder boss. Use a 3/16 inch drill. (A careful workman will drill out this pin without marring the lock). This will permit easy removal of the cylinder.
5. Push outward the small spring controlling the release pin, located at the end of the cylinder boss and plunger "K" (Illus. No. 30) will spring out.
6. Pry out the Woodruff key in plunger "K". This will permit removal of plunger "L" and spring "M".
7. The operating lever "E" can be removed by taking out the lever screw and prying the lever off of shaft "F".

ARTICLE NO. 59-1

To Disassemble Mechanics Universal Joints

The following revision in Article No. 59 applies to Big Six 127-inch Wheelbase cars after serial No. 2115661.

1. Place the joint in a vise so that all parts to be worked on are accessible.

2. Straighten the lips on the lock plates "R", "M", "N" and "O" on each side of the housing. (Illus. No. 62).

3. Remove the cover nuts "P" and "Q" on each side of the housing.

4. Mark the two halves "B" and "D" with a punch or chisel, before prying them apart, so that they will be assembled in the same relative position.

5. The two halves "B" and "D" can now be separated and the blocks "H" removed from pins "S" and "F".

6. If necessary to separate half of housing "D" from flange "E", drive out the pin "G" and press out shaft "F".

7. Reverse operations to assemble.

Make sure that a fibre washer "L" is placed on pins "S" and "F" before the blocks "H" are installed.

Note—It is very important that the mating surfaces of the two halves of the housing be sanded and shellacked upon assembly to insure against oil leaks.

If the front joint is being worked upon, place a washer "I" on each side of the felt "J". This is to prevent damaging the felt when the nut "K" is tightened.

Be sure the arow on the joint lines up with the one on the shaft.

Tools Required—Chisel, hammer, pliers, No. 25 open end wrench, ¼ inch socket wrench and small arbor press.

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8. Reverse operations to assemble.

When replacing the lock cylinder use a nail or similar instrument through the cylinder retaining pin hole to properly locate the cylinder. Then put in the permanent pin by tapping lightly until it reaches the bottom. Do not take chances of damaging the lock cylinder by striking hard on the pin.

Tools Required—No. 23, 25 and 27 open end wrenches, pliers, screw driver, cape chisel, hammer, .005 inch shim stock, hand drill, 3/16 inch drill.

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BIG SIX, SPECIAL SIX AND BUS CHASSIS SECTION

DIAGNOSIS

The following pages of diagnosis will be found of material value in tracing the sources of difficulty. The main headings have been taken directly from indications of trouble, such as "Brakes Do Not Hold" or "Brakes Squeak When Applied." Under these have been listed the causes for such conditions. Even the most experienced mechanic will find that such a list will often serve to jog his memory on causes which are infrequently encountered. Sections on "Test" and "Remedy" then follow except in a few cases where these items are so apparent as to need no explanation. In case more detailed information on any subject is required the General Information Section starting on page 13 or the Operation Articles starting on page 49 should be consulted.

BRAKES

Brake Pedal Sticks
Studebaker and Bendix Brakes

Cause

1. Brake return springs weak or broken.
2. Brake pedal or other parts of the brake mechanism seized.

Test

1. Inspect the brake cross shaft return springs, a broken spring can easily be seen. A weak spring will have no tension and will not pull the cross shaft back to its proper position when the brakes are released. If the trouble is not in the cross shaft return springs remove the wheels and inspect the brake shoe return springs on Bendix Brakes.

2. Disconnect the brake rods if necessary and test each moving part of the brake mechanism.

Remedy

1. See that the return springs on the shoes or bands and on the cross shaft are sufficient to pull the brakes back to their normal position. Broken or weak return springs must be replaced.

2. These parts can usually be freed up without removal by working them back and forth and lubricating them freely. However, if badly seized, they must be removed and polished with fine emery cloth. Lubricate them thoroughly before replacing.

Brake Drags or Binds
Studebaker Brakes

Cause

1. Brake bands improperly adjusted.
2. Brake bands not properly formed.
3. Brake band springs weak or broken.
4. Brake bands improperly lined.
5. Linings water-soaked or covered with grit.
6. Parts of brake mechanism seized.
7. Rear wheels out of line resulting from:
   - Rear axle housing sprung or broken.
   - Spring center bolt sheared.
   - Frame bent or broken at rear end.
   - Spring master leaf broken.

Test

1. Examine the band to see if it is rubbing against the drum at any point. This may be checked with a .015 of an inch thickness gauge. The gauge should pass between the band and drum at any point.

2. If the band does not conform to the shape of the drum and cannot be adjusted it is probably sprung. Check with a .015 of an inch thickness gauge as above.

3. Weak or broken brake band springs can be easily detected as they will have little tension and will not hold the band away from the drum properly.

4 and 5. A visual inspection of the band is necessary to determine if it is improperly lined. If the rivet heads project above the lining or if the lining is pulled too tight so that it does not lie flat on the band at all points the brake will drag on the drum. Also see if the linings are water soaked or covered with grit.

6. All parts of the brake mechanism should be inspected to see that they return to their proper position after application.

7. Check by measuring from the center of the front wheel spindle to the center of the rear axle shaft on each side. These measurements should be the same with the front wheels pointing straight ahead. Also test the rear wheel alignment with the Ideal Wheel Aligning Gauge.

This condition may also be indicated by a tendency of the car to go to the side of the road. This is not a positive indication, however, as front wheels out of line give the same effect.

If the housing is badly sprung, the axle shaft will bind (where it enters the differential side bevel gear) when attempting to remove or install it.

Remedy

1. The brake band should be adjusted so that there is a uniform clearance of .015 of an inch between the band and the drum at all points. (See Operation Article No. 38 or 40).

2. Remove the band and form it by means of Brake Band Forming Fixtures C. O. 416 or C. O. 418. (See Vol. 8).

3. The brake springs should be replaced with new ones. In case of coil springs, they can be stretched slightly to increase their tension and used in an emergency.

4 and 5. If the lining has not been properly applied it will be necessary to remove and reassemble it correctly. Clean the lining thoroughly before fastening it to the band. Be careful to countersink the rivets and see that the lining fits the band properly. See Operation Article No. 36.

6. These parts can usually be freed up without removal by working them back and forth and lubricating them freely. However, if badly seized they must be removed and polished with fine emery cloth. Lubricate them thoroughly before replacing.

7. If the rear axle housing is only slightly sprung, it may be straightened cold in a heavy press.

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PRINTED IN U. S. A.

If it is badly sprung or broken a new housing will be necessary. Never use heat in straightening this part. The frame, if broken, should be replaced with a new one to make the most satisfactory repair. However, it can sometimes be repaired. When sprung it may be heated, if necessary, to a dull red to straighten.

Brake Drags or Binds

Bendix Brakes

Cause

1. Brake shoes improperly adjusted.
2. Brake shoes out of shape or sprung.
3. Brake shoe return springs weak or broken.
4. Linings water soaked, covered with grit or grease.
5. Parts of brake mechanism seized.
6. Front wheel bearings very loose.
7. Rear wheels out of line, resulting from:
   - Rear Axle housing sprung or broken.
   - Spring center bolt sheared.
   - Frame bent or broken at rear end.
   - Spring master leaf broken.
   - Excessive endplay in axle shafts.

Test

1. Jack up all four wheels and try for turning freely. An improperly adjusted brake will bind the wheel or make a rubbing noise when the wheel is revolved.
2. Brake shoes which are sprung or out of shape cannot be adjusted to give a smooth even braking action.
3. Remove the wheels and make a visual inspection of brake return springs on the shoes and also on the cross shaft. Weak or broken return springs can be easily detected as they will have little tension and will not hold the brake shoes in their proper position.
4. A visual inspection will reveal the condition of the brake shoe lining.
5. All parts of the brake mechanism should be inspected separately to locate any seized parts.
6. Jack up the front wheel. Grasp the wheel by the top and bottom and attempt to move the wheel. Do not confuse a loose steering knuckle pin or bushings for loose wheel bearings.
7. Check by measuring from the center of the front wheel spindle to the center of the rear axle shaft on each side. These measurements should be the same with the wheels pointing straight ahead. Also test the rear wheel alignment with the Ideal Wheel Aligning Gauge.

This condition may also be indicated by a tendency of the car to go to one side of the road. This is not a positive indication, however, as front wheels out of line give the same effect. If the housing is badly sprung, the axle shaft will bind (where it enters the differential side bevel gears) when attempting to remove or install it. Use a dial indicator to check the axle shaft endplay.

Remedy

1. The brake shoes in all wheels should be so adjusted that the wheels revolve freely when jacked up and slow down or stop when slight pressure is applied on the brake cam lever. (See Operation Article No. 40) to adjust the brakes.
2. Brake shoes which have become sprung or out of shape should be replaced.
3. Weak or broken brake return springs must be replaced.
4. The brake shoe lining can be thoroughly brushed with a wire brush and then dried out with heat before replacing.
5. Lubricate all the brake connections and working parts with oil and work in good. If this does not free up the affected parts, they must be removed and polished with fine emery cloth. Lubricate the parts before replacing.
6. Remove the hub cap and cotter pin. Turn the bearing adjusting nut up tight and then back off until the wheel turns freely but there is no play.
7. If the rear axle housing is only slightly sprung, it may be straightened cold in a heavy press, if badly sprung or broken a new housing will be necessary. Never use heat in straightening this part.

The frame, if broken, should be replaced with a new one to make the most satisfactory repair. However, it can sometimes be repaired. When sprung it may be heated, if necessary to a dull red before straightening.

If the master leaf is broken or the spring center bolt sheared, these parts will have to be replaced. (See Vol. 1 to remove and replace spring). See Vol. 1 to adjust the axle shaft endplay.

Brakes Cannot Be Adjusted

Studebaker Brakes

Cause

1. Brake bands not properly formed.
2. Brake linings worn.
3. Brake linings improperly applied.
4. Brake shafts seized.
5. Brake clevises worn.

Test

1. If the band does not conform to the shape of the drum and cannot be adjusted it is probably sprung.
2. This can be determined only by visual inspection.
3. A visual inspection of the band is necessary to determine if it is improperly lined. If the rivet heads project above the lining or if the lining

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is pulled too tight so that it does not lie flat on the band at all points the band cannot be properly adjusted.

4. All parts of the brake mechanism should be inspected to see that they return to their proper position after application.

5. This may be indicated by excessive play in the brake pedal after properly adjusting the bands. This might be caused by worn clevises on one side only so that proper equalization of the brakes cannot be effected.

Remedy

1. Remove the band and form it by means of Brake Band Forming Fixtures C. O. 416 or C. O. 418. See Vol. 8.

2. If worn, the linings must be replaced.

3. If the lining has not been properly applied it will be necessary to remove and reassemble it correctly. Be careful to countersink the rivets and see that the lining fits the band properly.

4. These parts can usually be freed up without removal by working them back and forth and lubricating them freely. However, if badly seized they must be removed and polished with fine emery cloth. Lubricate thoroughly before replacing.

5. This condition can usually be overcome by replacing the clevis pins. However, if the clevises themselves are badly worn, new brake rods must be installed.

Brakes Do Not Perform Properly After Standard Adjustment
Bendix Brakes

Cause

1. Brake shoes out of shape.
2. Brake linings worn on one shoe.
3. Brake lining replacement attempted.
4. Brake cam or brake rod connections seized.
5. Brake clevises and working parts worn.
6. Brake cam reversed.
7. Loose or worn front wheel bearings.
8. Brake drums out of round.

Test

1. If the brake shoes do not conform to the shape of the drum and cannot be adjusted to hold without dragging when released they may be sprung or out of shape.

2. This can be determined only by visual inspection.

3. Inspection will tell whether the shoes have been relined. This operation cannot be successfully done except at the factory. When the lining is worn out new shoes should be installed and the old ones returned for credit.

4. All moving parts of the brake mechanism should be inspected to see that they return to their proper positions after application of the brakes.

5. This may be indicated by an excessive amount of play in the brake pedal after properly adjusting the brake shoes. It may be caused by worn clevises on one side only, or loose brake cam levers, so that proper equalization of the brakes cannot be effected.

6. The arrow on the cam (long side) must always point toward the primary shoe when the brakes are applied.

7. Jack up the wheel. Grasp the wheel by the top and bottom and attempt to move the wheel. Do not confuse a loose steering knuckle pin or bushing for loose wheel bearings.

8. Check the brake drums for being out of round.

Remedy

1, 2 and 3. Brake shoes that are out of shape, or have the linings worn and shoes that have been relined should be replaced with new shoes.

4. If badly seized, they must be removed and polished with fine emery cloth. Lubricate thoroughly. Before replacing lubricate parts as described in General Information.

5. This condition can usually be overcome by replacing the clevis pins. However, if the clevises themselves are badly worn, new brake rods must be installed.

6. Reverse the cam, being sure that the long side of the cam (arrow) is next to the primary shoe when the brake is applied.

7. Remove the hub cap and cotter key. Turn the bearing adjusting nut up tight and then back off until the wheel turns freely but there is no play.

8. Place in a drum turning lathe or grind concentric to within .006 of an inch. If a lathe or grinding machine is not available the drum should be replaced.

Brakes Do Not Hold
Studebaker and Bendix Brakes

Cause

1. Improper adjustment.
2. Linings worn.
3. Brake shoes improperly relined.
4. Lining coated with grease.
5. Rust or fine dust on linings.

Test

1. Jack up all four wheels and check each wheel separately. The wheel should turn freely when rotated with no rubbing or binding of the brake shoes or bands. When the brake pedal is held down each wheel should offer the same resistance to being turned which will vary with the pressure exerted on the pedal.

2. This can be determined only by visual inspection.

3. A visual inspection will reveal whether the brake shoes have been relined. This operation cannot be properly done except at the factory on Bendix Brakes.

4. If the brakes seem to be properly adjusted and the brake mechanism is in good condition and still the brakes do not hold, examine the lining on the brake shoes or bands to see if it is oil soaked.

5. A visual inspection will reveal if the linings are covered with rust or glazed.

Remedy

1. Adjust the brakes according to Operation Article No. 40.

2 and 3. (Bendix Brakes). If the linings are worn or have been replaced the brake shoes should be replaced with new ones.

2 and 3. (Studebaker Brakes). If worn, the linings must be renewed. However, if the lining has not been properly applied it will be necessary to remove and reassemble it correctly.

4. Oil or grease can sometimes be removed by washing the linings in gasoline or if badly soaked by boiling the grease out with a blow torch. After completing either of the above operations dry the linings thoroughly and then clean with a wire brush.

However, there is no sure cure for greasy linings except replacement of the shoes. Before replacing the shoes the cause of the grease leak should be located and remedied.

5. Rust or dust can be removed by brushing briskly with a wire brush.

Brakes Squeak or Chatter

Studebaker and Bendix Brakes

Cause

1. Exposed rivets contacting on drum.
2. Dirty or glazed lining.
3. Loose wheel bearings or drums.
4. Loose spring main clips.
5. Drum out of round.
6. Linings loose on shoes or bands.
7. Grease on linings.
8. Brakes not equally adjusted.
9. Loose anchor pins (Bendix Brakes).
10. Rusty or dry moving parts of brake.
11. Improper clearance between the toe of the secondary shoe and drum. (Bendix Brakes.)

Test

1. Remove wheels and examine brakes for any exposed rivets.

2. A visual inspection will reveal the condition of the brake lining.

3. Jack up the front wheels. Grasp the wheel at the top and bottom and attempt to move the wheel. Do not confuse a loose steering knuckle pin or bushing for loose wheel bearings. Test the nuts holding the drum in place as they should be tight at all times.

4. Test the spring main clip nuts to see if they are tight.

5. Examine the brake drums for being out of round.

6. Examine the brakes for any loose linings.

7. A visual inspection will reveal if there is grease on the brake linings.

8. Jack up all four wheels and check each wheel separately. The wheel should turn freely when revolved with no bind or rubbing of the brake shoes.

When the brake pedal is held down each wheel should offer the same resistance to being turned which will vary with the pressure exerted on the pedal.

9. Test the anchor pins for being loose or worn. (Bendix Brakes).

10. All parts of the brake mechanism should be inspected separately to locate any dry or seized parts.

11. Check the clearance with a feeler gauge, the clearance should be the same or up to .002 of an inch more than at the heel. (Bendix Brakes).

Remedy

1. If any rivets are exposed they should be reset or replaced. If lining is badly worn, replace with new lined shoes or reline the brake bands.

2. Dirt and grease which have been ground and burned in are very difficult to remove. If the linings cannot be cleaned by washing with gasoline the shoes should be replaced, or the bands relined.

3. Remove the hub cap and turn the bearing adjusting nut up tight and then back off until the wheel turns freely but has no play. Tighten any drum nuts that are found loose with a heavy wrench.

4. Tighten the spring main clips with a heavy wrench.

5. Place in a drum turning lathe or grind concentric to within .006 of an inch. If a lathe or grinding machine is not available the drum should be replaced.

6. Loose linings should be riveted or shoes replaced with new ones.

7. See remedy item 1 under Brakes Do Not Hold Properly On All Four Wheels.

8. The brakes in all wheels should be so adjusted that the wheels revolve freely when jacked up and slow down or stop when slight pressure is applied on the brake cam pedal.

9. Tighten or replace loose anchor pins. (Bendix Brakes).

10. Lubricate all the brake connections and working parts as described in General Information.

11. Adjust the toe of the secondary shoe with the proper clearance.

Linings Wear Rapidly
Bendix Brakes

Cause

1. Drum scored.
2. Brakes dragging.

Test

1. A visual inspection will tell if the brake drums are scored.

2. Jack up the car and try all four wheels for turning freely. An improperly adjusted brake, broken or weak return springs will make a rubbing noise when the wheel is turned.

Remedy

1. Place in a drum turning lathe or grind concentric to within .006 of an inch. If a lathe or drum grinding machine is not available the drum should be replaced.

2. The brake shoes in all wheels should be so adjusted that the wheels revolve freely when jacked up and slow down or stop when slight pressure is applied on the brake cam lever, weak or broken brake return springs must be replaced.

Brakes Grab
Bendix Brakes

Cause

1. Loose wheel bearings.
2. Drums out of round.
3. Drums scored.
4. Loose spring clips.
5. Linings soaked with grease.
6. Loose linings.
7. Loose brake camshaft brackets.
8. Improper setting at toe and heel of the brake shoes.
9. Improper setting of the eccentric adjustment.
10. Loose anchor pins or brake backing plate.
11. Relined with improper brake lining.

Test

1. Jack up the front wheels. Grasp the wheel by the top and bottom and attempt to move the wheel. Do not confuse a loose steering knuckle pin or bushing for loose wheel bearings.

2. Check the brake drums for being out of round. If the runout is more than .010 of an inch they must be trued up or replaced.

3. Examine the brake drums for any scored conditions.

4. Test the spring clips with a heavy wrench to make sure they are tight.

5. A visual inspection will reveal if the brake shoe linings are soaked with grease.

6. Inspect the shoes to see if the rivets are loose in the shoes, or if the lining is loose on the rivets.

7. Test the brake cam shaft bracket bolt nuts to see if they are drawn up tight.

8. Remove the cover from the brake drum slot and check the toe and the heel of the auxiliary and secondary shoes with feelers. Both ends of the same shoes must be alike within .002 of an inch. It is recommended that the heel of the shoes be set with the same clearance as the toe or from .000 to .002 of an inch closer.

9. Jack up the car and test each wheel for free movement.

10. Test the anchor pin and backing plate nuts for looseness. They should be tight at all times.

Remedy

1. Remove the hub cap and cotter key. Turn the bearing adjusting nut up tight and then back it off until the wheel turns freely but has no play.

2. and 3. Place the wheel and drum in a turning lathe or grind concentric to within .006 of an inch. If a turning lathe or grinding machine is not available the drum should be replaced.

4. Tighten any loose spring clip nuts with a heavy wrench, first making sure that there is a lock washer between the nut and axle.

5. Oil or grease can sometimes be removed by washing the linings in gasoline or if badly soaked by boiling the grease out with a blow torch. If a blow torch is used be very careful not to burn the lining or get the shoes too hot. After completing either of the above operations dry the linings thoroughly and then clean with a wire brush.

However, there is no sure cure for greasy linings except replacement. Before replacing the shoes the cause of the grease leak should be located and remedied.

6. Linings that are loose can be riveted, however if the lining has extra large rivet holes, the shoes should be replaced.

7. Tighten the camshaft bracket bolt nuts, being sure they are locked with a cotter key.

8 and 9. If both ends of the same shoe are not within .002 of an inch, adjust the anchor pins as follows: Turn eccentric adjustment away from articulating pin and leave loose. Loosen anchor pin nuts and hold the brake on tight with a stillson or monkey wrench, tap the anchor pins out against the drum and try to turn the wheel forward (with the brake applied). Hold the brake on and tighten the anchor pin nuts, then adjust eccentric.

Turn eccentric in the direction the wheel revolves when the car moves forward, until secondary

Issued June 1, 1929
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PRINTED IN U. S. A.

shoe is tight against the drum. Then gradually back off the eccentric until the wheel is just free. Hold the eccentric in this position and tighten the lock nut. Recheck the toe and heel clearance of each shoe.

10. Tighten anchor pin and backing plate nuts with a heavy wrench, making sure each nut is locked with a lock washer.

11. Install brake shoes that are lined with the proper lining.

Brakes Do Not Hold Properly on All Four Wheels

Bendix Brakes

Cause

1. Grease on linings.
2. Linings badly worn on one brake.
3. Brakes not properly equalized.
4. Bent or badly worn brake levers or parts.
5. Control lever position incorrect.

Test

1. A visual inspection will tell if there is grease or oil on any of the brake shoes.

2. When the lining becomes worn down to the rivets, or when the lining is worn very thin in places new shoes should be installed.

3. Jack up all four wheels and check each wheel separately. Each wheel should rotate freely with no binding or rubbing of the brake shoes.

Hold the brake pedal down with a block of wood or pedal jack. Each wheel should offer the same resistance to being rotated.

4. Inspect the brake levers for being bent out of shape, also inspect all moving parts for wear.

5. The angle of the control levers with the brake rods should be about 70° with the brakes released.

Remedy

1. Oil or grease can sometimes be removed by washing the linings in gasoline or if badly soaked by boiling the grease out with a blow torch. After completing either of the above operations dry the linings thoroughly and then clean with a wire brush.

However, there is no sure cure for greasy linings except replacement of the shoes. Before replacing the shoes the cause of the grease leak should be located and remedied.

2. If the linings are badly worn, the shoes should be replaced.

3. See Operation Article No. 9 to equalize the brakes.

4. Brake levers that are found bent can be straightened. Badly worn parts should be removed and new ones installed.

5. See Operation Article No. 9 to set control levers at correct angle.

Propeller Shaft Parking Brake Does Not Hold

Cause

1. Improper adjustment.
2. Lining worn.
3. Lining coated with grease.
4. Brake band out of shape.

Test

1. Inspect the band to see that there is a uniform clearance of 1/32 of an inch between the band and drum. Examine the brake linkage to see that all moving parts work freely.

2. This can be determined by a visual inspection.

3. If the brake band is properly adjusted and all moving parts work freely, examine the lining on the band to see if it is covered with grease.

4. If the band does not conform to the shape of the drum with the brake applied, which can be checked by using a 1/32 of an inch thickness gauge the band is sprung.

Remedy

1. See Operation Article No. 37 to properly adjust the brake band.

2. If worn the lining must be replaced.

3. Grease can sometimes be removed by washing in gasoline or if badly soaked by boiling the grease out with a blow torch. If a blow torch is used be very careful not to burn the lining or get the band too hot. After completing either of the above operations dry the linings thoroughly and clean with a wire brush. However, there is no sure cure for a greasy lining except replacement. Before replacing the lining the cause of the trouble should be remedied. The more common causes are improperly fit gasket or damaged oil guard shield on the universal joint.

4. Remove the band and reshape it by using Brake Band Forming Fixture C. O. 418.

BODY

Door Check Buckling in Guide

Cause

1. Slot in door not lined up with slot in the hinge pillar.
2. Not enough clearance in the door guide.
3. Door check damaged.

Test

1. Inspect the door check to see if it is binding on the top or bottom. If the slots are badly out of line it will be noticeable when the door is opened.

2 and 3. A visual inspection will tell if the door check is binding in the door guide, or if it has become damaged.

Remedy

1. Remove the door trimming and check. File the slot in the door to line up with the slot in the hinge pillar.
2. File the door slot to give more clearance on the top and bottom, if binding on the sides insert a flat tool in the door slot and pry towards the inside, this will give more clearance in the guide and allow the check to slide freely.
3. A door check that has become damaged should be replaced.

Door Rattles

Cause

1. Loose dovetail.
2. Strikers do not properly latch doors.
3. Hinge pins worn or too small.

Remedy

1. Remove the dovetail and rubber support. Insert a fiber or cardboard shim under the rubber support, the gap opening should be ¼". The male dovetail should have at least $\frac{3}{16}$" engagement in the female.
2. Strikers that do not properly latch the door should be replaced.

Care must be taken when applying the door lock strikers, so that the door lock striker will be parallel with the door lock bolt. The strikers have serrations and can easily be adjusted to the proper tension to keep the door from rattling.

3. Replace worn hinge pins. If door still rattles, install larger hinge pins.

Door Closes Hard

Cause

1. Lower edge of door riding on the sill panel.
2. Door hinge pins binding.
3. Door hinges bent or out of line.
4. Door sprung out of shape.
5. Windlace out of place on hinge side of door.

Test

1. A door riding on the sill will make a rubbing noise and also will show wear on top of sill panel if used very much in this condition.
2. Hinge pins that are binding will cause the door to swing hard when opening and closing.
3. Door hinges out of line will cause the door to swing hard at certain positions.
4. Doors bent or sprung will bind when being opened or closed.
5. A visual inspection with the door closed will show if the windlace is out of place.

Remedy

1. Remove the scuff plate, remove the nails in the sill panel (the nails exposed when the scuff plate is removed) and drive the panel in tight against the sill. Renail and replace scuff plate.
2. Remove the hinge pins and lubricate with a good grade machine oil, if binding badly, polish slightly with fine emery cloth and lubricate. In cases where the pins are extra tight the hinge hole can be reamed oversized, care being taken not to get it too large.
3. In most cases where the hinges are bent or out of line they can be straightened without removing from the car with a hinge straightening tool.
4. A door that is sprung out of shape causing it to close hard can generally be straightened by using a door bending iron.
5. To move the windlace away from the door loosen the pillar facing and wire on binding. Take out the tacks and move the windlace back to such a position that it will not be pinched when the door is closed. Retack the wire on binding and pillar facing.

Hood Rattles

Cause

1. Anti-rattler improperly bent.
2. Radiator support rods improperly adjusted.
3. Radiator not properly shimmed.

Remedy

1. If the anti-rattler is bent in too far it will not support the hood, bend it out slightly or to the point where it will have tension on the hood.
2. Adjust the radiator support rods so that the front edge of the hood will ride on the tape rather than on the radiator shell.
3. If the hood has very little tension on the hood locks, and if found resting on the frame sills, shim the radiator slightly higher, to give the hood more tension on the hood locks.

Issued June 1, 1929
Insert in Volume Two, immediately after page 10-B
PRINTED IN U. S. A.

GENERAL INFORMATION

The following section is one containing information of a general nature and may be used to supplement the Diagnosis and Operation Article Sections. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised paragraph will be carried at the bottom of the green sheet.

For example, the reader is interested in paragraph 2-A Rear Wheel Brake Adjustment. Before he reads this, a glance at the bottom of the page will tell him whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the paragraph number 2-A such as 2-A-1 or 2-A-2 then he knows that the information on the green sheet must also be read to get the complete instructions.

BRAKES

The following paragraphs give instructions on the inspection and adjustment of the service and parking brakes.

On two and four wheel, hydraulic and mechanical brake equipment the rear wheel brake band adjustment is exactly the same.

The front wheel brakes on 4-wheel mechanical brake equipment may be adjusted by means of the front brake rod adjustable clevises.

The front wheel brakes on hydraulic brake equipment require no adjustment except the centering of the cam support, which is described under "Front Brake Cam Support Adjustment."

1-A—Inspection and Test of Hydraulic Brakes

See that the rear wheel brake bands are properly adjusted and equalized. The rear wheel brakes should operate through the last 3 inches of pedal travel just as efficiently as on 2-wheel brake equipment.

Inspect the transmission for the proper amount and grade of oil. Oil should stand at the level of the filler hole. Use medium engine oil in warm weather and light, cold test oil in cold weather.

The oil pressure, as indicated by the gauge on the instrument board, should be 75 pounds, when the brake pedal is pressed not more than 2 inches at a car speed of 30 miles per hour. If the pressure is not correct, check the travel of the pump operating valve and brake pedal. Then adjust the oil pressure relief valve.

No adjustment is necessary on the front wheel brakes.

Instructions on the above points are given in the following paragraphs. Attention to these details will usually put the brakes in proper operating condition. The additional information given should be carefully studied to provide for unusual conditions.

2-A—Rear Wheel Brake Adjustment

Examine the brake bands to see that they are round. If they are not, they will not conform to the shape of the brake drum and it will be impossible to adjust them properly. See "Forming the Brake Bands."

There are four points of adjustment on the rear wheel brake bands, two adjusting screws, one at the rear and one on top of the band and two adjusting nuts at the front of the band. (Illus. No. 18).

To make the adjustment, first turn the rear adjusting screw until the clearance between the brake lining and the brake drum at this point is .015 of an inch. Then turn the adjusting nuts below the large spring at the front of the band to give the same clearance to the lower half of the band. Turning these nuts up loosens the band and turning them down tightens it. After making this adjustment be sure the lower nut is locked against the upper one.

Next turn the adjusting screw at the top of the band to give proper clearance. Then turn the adjusting nut at the front of the upper half of the band. Make sure that the clearance is now uniform and that the brake is not dragging. The rear axle should be jacked up and the clearance checked at all points with a .015 of an inch feeler gauge.

3-A—Four Wheel Mechanical Brake Adjustment

Inspect the brake pedal arm to see that it does not come closer than ⅛ of an inch to the under side of the toe board. If it is closer than this, or if the clearance is more than ¼ of an inch, remove the clevis pin connecting it to the brake rod and adjust the clearance by means of the adjusting screw in the lower part of the arm.

Loosen the nuts holding the pedal pad in the pedal arm and adjust the clearance between the pedal pad and the toe board to 5½ inches. Then tighten the nuts.

See that the center equalizer is free to go back against the stops and then connect the center brake rod to the brake pedal. If necessary, move the adjustable clevis at the front end of the rod enough to permit making the connection without buckling the rod or pulling the equalizer away from the stops.

Adjust the stop screws on the frame side members so as to bring the outside ends of the two brake cross shafts approximately in the center of the holes in the frame side members.

Now adjust the rear wheel brake bands as described under "Rear Wheel Brake Adjustment."

Before adjusting the front wheel brakes, disconnect the front brake rods and adjust the brake cam

support as described under "Front Brake Cam Support Adjustment."

Turn the adjustable clevises on the front brake rods so that when the clevises are fastened to the levers, the front brakes will be applied as much as possible without actually rubbing the drums.

These clevises will ordinarily be fastened in the lower hole of the front brake long lever on the Big Six and in the upper hole on the Standard Six. If these positions do not give the desired front brake action, the clevises may be moved to one of the other two holes.

4-A—Testing Mechanical and Hydraulic Brakes Separately

Before proceeding with any detail test or repair of the braking system, on four-wheel hydraulic brake equipment, it should be determined in a general way, whether the difficulty lies with the mechanical or hydraulic brakes.

This can easily be done by disconnecting the rod which links the brake pedal with the pump operating valve. This renders the hydraulic brakes inoperative.

The car should then be given a thorough test using mechanical brakes only. These should equal in every way the brakes furnished on two-wheel brake equipment.

If the brakes seem faulty in operation under this test, they should be carefully inspected in accordance with paragraphs entitled "Rear Wheel Brake Adjustment", "Checking Rods, Shafts and Pins for Free Movement" and "Oil on Brake Lining".

5-A—Checking Rods, Shafts and Pins for Free Movement

Free movement of all brake rods, shafts, levers and pins is essential for perfect application and equalization of the brakes.

These parts are exposed to mud and water and should be frequently lubricated and cleaned when necessary.

If the clevis pins holding the bell crank to the lower part of the rear wheel brake band and adjusting link (Illus. No. 22) are found to be binding they must be removed and polished with fine emery cloth. Lubricate thoroughly before replacing.

To insure equalization of the rear brakes, the rear brake shafts must rotate freely. If found to be binding, these can usually be freed up without removal by working them back and forth and lubricating them freely.

The front and rear brake equalizers, the front brake shoe long levers and the front brake shoe cams should be carefully inspected and cleaned if necessary.

The front brake shoes must move freely on their pins. If they do not, remove the shoes and clean the pins thoroughly.

The pump pistons on hydraulic brake equipment, should move with comparative freedom. By grasping the end of the piston stem with a pair of pliers it should be possible to move it back and forth when turned in any position. If it seems to bind, loosen the packing nut to make sure this is not the cause. Then loosen the cover cap screws slightly and tap the cover in an effort to align it with the piston stem.

If this is not successful, remove the piston, and check the stem for squareness.

If the piston still binds, it is probable that the bushing in the cover has not been reamed true. This should be inspected and replaced if necessary.

The pump should also be checked to see that it turns freely. If it has been worked on and not properly reassembled, the gears may bind in the pump body. In this case, remove the propeller shaft and pull the transmission shaft flange and brake drum. Replace the flange without the drum and loosen the pump cover screws slightly. Rotate the transmission shaft, tapping the pump to assist it in aligning itself. During this operation, have the cover screws just tight enough to hold the body in position as it is shifted. Be sure to tighten the screws before pulling the flange to replace the brake drum and propeller shaft. If the car has been run for a considerable length of time with the pump in a misaligned condition, it may be that some of the parts will need replacing.

6-A—Transmission Oil (Hydraulic Brake Equipment)

The oil in the transmission case should stand just at the level of the filler hole in the side of the case. If it does not, enough oil should be added to bring it to the proper level.

If the oil is allowed to get too low, the pump will draw a certain amount of air and will not develop full pressure. This will be indicated by a lower pressure gauge reading or sometimes by fluttering of the indicator hand.

3-A-1 FOUR WHEEL MECHANICAL BRAKE ADJUSTMENT

The following revision in Article 3-A applies to Custom cars having the brake stop located at the rear brake bell crank.

Inspect the brake pedal arm to see that it does not come closer than ⅛ of an inch to the under side of the toe board. If it is closer than this, or if the clearance is more than ¼ of an inch, remove the clevis pin connecting it to the brake rod and adjust the clearance by means of the adjusting screw in the lower part of the arm.

Loosen the nuts holding the pedal pad in the pedal arm and adjust the clearance between the pedal pad and the toe board to 5½ inches. Then tighten the nuts.

See that all the brake rods are working freely and that the rear brake rod bell cranks go back against the stops, which are now located on the rear axle brake spring brackets. If necessary, move the adjustable clevis at the front end of the rod enough to permit making the connection to the brake rod without buckling the rod or pulling the bell cranks away from the bracket stops.

Adjust the stop screws on the frame side members so as to bring the outside ends of the two brake cross shafts approximately in the center of the holes in the frame side members.

Now adjust the rear wheel brake bands as described under "Rear Wheel Brake Adjustments."

Before adjusting the front wheel brakes, disconnect the front brake rods and adjust the brake cam support as described under "Front Brake Cam Support Adjustment."

Turn the adjustable clevises on the front brake rods so that when the clevises are fastened to the levers, the front brakes will be applied as much as possible without actually rubbing the drums.

These clevises may be connected to any of the three holes in the long lever in order to give the desired front brake action.

Issued September 15, 1927
Insert in Volume Two, after page 14.
PRINTED IN U. S. A.

Issued June 1, 1929
Insert in Volume Two, after page 14-A

PRINTED IN U. S. A.

1-A-1—Brake Principle and Construction Features
(Bendix 4-Wheel Brakes)

Three outstanding features characterize the brake. The most important of these is the servo action by which light pedal pressure is made to induce powerful braking action. Three lined shoes the primary, secondary and auxiliary, are used, with the auxiliary and the secondary anchored at one end to the backing plate. The primary is hinged to the secondary so that they move together.

When the brake is applied, the operating cam pushes the primary and auxiliary shoes against the drum. The primary being free to move, is dragged by its contact with the drum in the direction of the drum rotation. This movement of the primary shoe forces both itself and the secondary shoe more tightly against the drum and so increases the braking effect.

The second important feature is the great area of drum contact secured by overlapping the three shoes. The linings actually contact with much more of the circumference of the drum than the average two-shoe type. In addition the shoes expand in a perfect circle so that the whole surface of each shoe is utilized to the fullest extent.

Third, the whole of the braking mechanism is enclosed so that mud and dust are excluded, insuring perfect operation at all times and long life of the parts.

All parts are mounted on a circular steel disc, known as the backing plate. The backing plate not only supports the brake parts but also helps to keep out the dirt and water.

2-A-1—Brake Adjustment
(Bendix 4-Wheel Brakes)

Before attempting to adjust the brakes jack up all four wheels, with the brakes released, check the frame brake cross shaft, rods, etc. to make sure they are not binding. Check the spring clips to make sure they are tight.

If adjusting the brakes for wear only, the anchor pins need not be adjusted. The only time the anchor pins need adjusting is when fitting new shoes, anchor pin nuts found loose or when other adjustments fail to give satisfactory results.

To adjust and equalize the brakes see operation Article No. 40.

3-A-2—Eccentric Adjustment
(Bendix 4-Wheel Brakes)

The eccentric adjustment is provided to compensate for the natural wear of the brake lining. Its function is to control the clearance between the primary and secondary shoes and the brake drum. To keep the secondary shoes from contact with the drum when the brake is not applied, a spring fastened at one end to a pin on the backing plate is hooked into the end of the secondary shoe near the articulating pin. This spring holds the articulating pin of the primary and secondary shoes against the eccentric pin and turning the eccentric pin causes the shoe to move towards or away from the drum. It is adjusted from the outside of the backing plate where it is held in position by a lock washer and nut.

5-A-1—Lubrication of Brake Parts and Hook-up for Free Movement
(Bendix 4-Wheel Brakes)

The efficient operation of the service brakes is to a degree dependent upon the proper lubrication of the various parts of the braking system. It is therefore important that the following instructions be given your close attention:

The lubrication of the brake system pivotal points and operating parts of an operation which, without due care, can be overdone, and should not be attempted without first removing the shoes from the axle. After removing the shoes from the axle, the articulating pin (which is the hinge pin) connecting the primary and secondary shoes can be taken out of its bearing in the two shoes.

All wearing parts should be hand brushed, using a stiff brush and then wiped clean with a cloth. Apply a thin, even coat of grease to all wearing parts, such as anchor and articulating pins, roller pins (removable type), etc. Shoes having plates which contact with the brake operating cam should have the cam plates cleaned and lubricated with a thin, even coat of grease.

Caution—A thin coating of grease means grease that cannot be wiped off with the fingers. Excess grease or oil will work into the brake linings when used in quantities greater than recommended and will cause, in most cases, a rapid break down of the lining braking efficiency. Grease on linings in small quantities causes brakes to grab, and grease in large quantities causes brakes to have little or no braking effect.

The hook-up which includes the brake actuating means from the pedal and hand levers require lubrication at least once a month. This lubrication is not so exacting, but is of even greater importance as the parts are usually unprotected and are accordingly subject to "sticking" unless regularly lubricated as follows:

Lubricate with "600-W" oil or its equivalent all cross shafts, pedal and hand brake lever bearings. Oil every clevis pin and connection. Pivotal points or pendulum levers and operating levers on crank and lever systems should be oiled regularly as well as the frame ball ends with Bendix-Perrot controls.

Two or three times a year slip back the cover on the universal joint of the Bendix-Perrot control, which is located over the king pin and put in grease which does not channel, preferably a grease similar to spicer Universal Joint Grease. Do not try to pack too full as by overloading you may force the grease into the brake.

In replacing the shoes, check the return springs. These springs should be of sufficient strength to pull the shoes back and revolve the cam and lever, back to the normal position in which they rest when the brakes are "off".

Use a medium engine oil in the transmission of cars with hydraulic brake equipment in warm weather and a light, cold-test oil in cold weather.

7-A—Checking Brake Pump Oil Pressure (Hydraulic Brake Equipment)

An accurate check on the pressure developed in the pump may be made in the following manner, without taking the car on the road.

Jack up the rear wheels and brace the axle firmly.

Block the service brake operating levers so they cannot move. This can be accomplished by placing a bar or block of wood between the ends of the levers so that the pressure will be applied against the block.

Start the engine and with the transmission in high gear, run the car at a speed of 30 miles per hour.

Push the brake pedal down not more than two inches. The service brake oil pressure gauge on the instrument board should indicate a pressure of 75 pounds.

If it does not show this pressure, adjust the relief valve as instructed under "Adjustment of Oil Pressure Relief Valve."

Excessively low pressure may be due to any of the following causes:

Weak relief valve spring.

Relief valve does not seat properly.

Operating valve does not entirely close by-pass post in two inches of pedal travel. See "Checking Travel of Brake Pedal and Pump Operating Valve."

Defective pump housing or cover gaskets.

Face of pump cover or housing not true, permitting leaks between passageways.

Sloppy pistons. This is improbable as they may have as much as .007 of an inch clearance without serious effects.

Defective service brake oil pressure gauge.

8-A—Checking Travel of Brake Pedal and Pump Operating Valve (Hydraulic Brake Equipment)

There should be a clearance of 5 inches between the under side of the brake pedal and the toe board.

If the clearance is not correct, loosen the nuts holding the pedal pad to the pedal arm and screw it in or out of the arm as required. Tighten the nuts after adjustment.

On 2-wheel brake equipment there is about 2 inches movement of the pedal before brakes are applied, so that they operate through the last 3 inches of pedal travel.

On hydraulic brake equipment, the brakes are designed to operate during the first 2 inches of pedal travel, or the amount ordinarily required to take up the slack in the pedal. From 1⅝ to 2 inches of pedal movement should, therefore, cause the pump operating valve to completely close the by-pass port.

To check the travel of the valve, disconnect the brake pedal to valve rod at the valve. Pull out the valve and remove the packing nut. With a scale which will hook over the edge of the by-pass port, measure the distance from the outer edge of the by-pass port to the edge of the valve cylinder. Measure a similar distance on the valve from the inner end and place a mark at that point. See Illus. No. 6. Reassemble the valve and rod. The mark on the valve should stand exactly at the outer edge of the cylinder with the brake pedal released. If it varies less than 1/16 of an inch it can be correctly located by bending the rod slightly.

If the variation is greater than 1/16 of an inch a new brake pedal to valve rod of the proper length should be installed.

After the valve is correctly located, replace the packing nut and packing.

9-A—Oil on Brake Lining

Ordinarily, the effect of oil on the brake lining and the way it reduces its efficiency needs no comment. On cars with 4-wheel brakes, however, the subject is particularly important.

The ratio of braking effort proportioned between the front and rear wheels is carefully laid out to prevent all possibility of the front wheels locking.

Oil or grease on the rear wheel brake bands will lower their efficiency and if present in large enough quantities, will so reduce the effective braking effort as to cause the front wheels to receive more than the rear.

Oil or grease can usually be removed by washing the lining in gasoline. However, if it has become caked and burned in, this method will not be effective. In this case, relining will be necessary.

The parking brake should also be kept free from

grease and oil. It will be necessary to see that the front universal joint on Big and Special Six cars is not filled more than one-third full and that the grease retainer is in good condition.

On hydraulic brake equipped models, oil will be thrown out past the transmission shaft flange if the oil return grooves in the pump cover or the hole draining these grooves become clogged. If this condition occurs, it will be necessary to remove the pump cover and clean it thoroughly.

10-A—Front Brake Cam Support Adjustment

Although this has been termed an adjustment, it is not one in the usual sense of the word. The support is made adjustable only to compensate for inequalities in the brake lining, etc., and when once properly located, should not again need to be touched except after replacing a front brake shoe, relining the front brakes or some similar operation.

To determine whether the support is properly located, pull back on the front brake long lever and test the clearance between the brake lining and the drum with a .020 of an inch feeler gauge. Apply the feeler near the center of each shoe. The clearance should be too small for it to enter.

If necessary to relocate the support, loosen the two cap screws "C" (Illus. No. 12) holding the support to the steering knuckle. Tap the support lightly with a hammer to break it loose.

Pull back on the front brake long lever (Illus. No. 14) and test the clearance between the brake lining and the drum as instructed above.

With the brake shoes held in firm contact with the drum in this manner, tighten cap screws "C" (Illus. No. 12).

11-A—Proper Position of Front Brake Long Lever

If the front brake connecting link (Illus. No. 14) is removed, the position of the front brake long lever may be slightly disturbed when replacing the link, and will not be in a position to give greatest efficiency. This will be due to the fact that the plugs in the ends of the connecting link are not returned to their original position, making the link either shorter or longer.

The front brake long lever should point down at an angle of 45 to 50 degrees ahead of vertical.

To make a slight readjustment, remove the cotter pins from the plugs in the ends of the connecting link. Turn the plugs in opposite directions in order to make the link shorter or longer as required.

Do not unscrew the plugs far enough to make it impossible to replace the cotter pins.

12-A—Adjustment of Oil Pressure Relief Valve

(*Hydraulic Brake Equipment*)

The relief valve is properly set at the factory for average conditions. If the brakes do not seem to operate properly, inspect the entire system carefully before changing the adjustment of the valve.

If necessary to make an adjustment, first check the pressure as instructed under "Checking Brake Pump Oil Pressure."

Loosen the relief valve lock nut and turn the valve out to decrease the pressure, or in to increase it.

The oil pressure gauge should show 75 pounds when making the above mentioned check.

Although this pressure will be found best for average conditions, if the owner desires slightly harsher brakes the pressure can be increased 5 or 10 pounds without any detrimental effects.

Be sure to tighten the lock nut.

13-A—Relining Rear Wheel and Parking Brake Bands

In relining the rear wheel brake bands, use the same make and grade of lining as that used on the front wheel brakes. This is very important, as the proper ratio of braking effort must be maintained between the front and rear wheels.

After removing the brake bands, cut off the rivets holding the lining, with a small cold chisel. Be careful not to spring the band.

Place a new lining on the band and drill a rivet hole in one end.

Countersink the hole in the lining to the size of the rivet head, insert the rivet and head it over.

Be sure the rivet head is pulled well into the lining to prevent rubbing the brake drum.

Put in the other rivet in the same end of the lining in a similar manner.

Then put in the remaining rivets, one at a time. Each hole should be drilled and the rivet headed over before the following hole is drilled. Be careful not to pull the lining so tight that it is pulled away from the band, leaving an air space between the band and the lining.

The operation of riveting will probably distort

8-A-1 CHECKING TRAVEL OF BRAKE PEDAL AND PUMP OPERATING VALVE

(*Hydraulic Brake Equipment on Busses*)

On busses carrying the adjustable pedal to equalizer rod the clearance between the pedal pad and toe board should be 6 inches.

The pedal to equalizer rod should be so adjusted that the clevis pin at the equalizer bar stands at a position to the forward side of the elongated hole in the equalizer bar.

After checking the pump operating valve travel as directed in Article 8-A, the new type brake pedal to valve rod which has an adjustable clevis at the front end, can be set to correctly locate the valve.

The remainder of the adjustments are performed the same as given in previous instructions.

Issued September 15, 1927
Insert in Volume Two, after page 16.
PRINTED IN U. S. A.

9-A-1—Grease on Brake Lining (Bendix 4-Wheel Brakes)

Ordinarily, the effect of grease on the brake lining and the way it reduces the efficiency of the brakes need no comment.

On cars with four wheel brakes, the subject is particularly important.

Grease on the rear wheel brake shoes will lower their efficiency and if present in large enough quantities, will so reduce the effective braking effort as to cause the front wheels to receive more than the rear.

Grease can sometimes be removed by washing the linings in gasoline, or if badly soaked by boiling the grease out with a blow torch. After completing either of the above operations dry the linings thoroughly and then clean with a wire brush. However, there is no sure cure for grease on linings except replacement of the shoes. Before replacing the shoes the cause of the grease leak should be located and remedied.

Note—Do not pack the front wheel hub caps with grease as this will force the grease out into the brake shoe lining. Remove the wheel and pack the bearings with cup grease.

10-A-1 Brake Cam Bracket (Bendix 4-Wheel Brakes)

On the wheel side of the backing plate is the cam bracket which is attached to the backing plate by two bolts which pass through slots in the plate. Because these bolt holes are elongated it is possible for the cam bracket to be moved endwise.

The bracket should be bolted to the backing plate sufficiently tight to prevent a movement of the bracket on the backing plate by hand but not so tight but that a sharp blow of a hammer will move it. In cases where the moving carrier bracket is not incorporated, the cam itself is slotted so that it can move on its shaft under similar conditions. Like the carrier bracket, it is held by friction, and the special cap screw that holds the cam on its shaft should always be screwed down firmly to the shoulder of the screw to prevent shifting of the cam due to road shocks. The object of this construction is to allow the operating cam to center itself between the primary and auxiliary shoes. This centering movement takes place on the first hard brake application, and the cam bracket does not thereafter move except to compensate for lining wear.

11-A-1—Proper Angle of Control Levers With Brake Rods (Bendix 4-Wheel Brakes)

The brakes are designed to operate with the control levers at approximately a 70° angle with the brake rods (with the brakes released) in order to have the same braking efficiency under all driving conditions. If the brake rod adjusting nut is used to take up the brakes over a long period of service, the brake long lever will be out of its proper position which will cause unsatisfactory brake action. To reset the control levers see adjusting the brakes, Operation Article No. 40.

Issued June 1, 1929
Insert in Volume Two, after page 16-A

PRINTED IN U. S. A.

the band somewhat and it should be shaped as described under "Forming the Brake Bands."

14-A—Relining Front Brake Shoes

Relining the front brake shoes is an operation which will very seldom have to be performed. The shoes are amply large so that under ordinary circumstances, they should give long service.

When it finally becomes necessary to reline the shoes, they should be sent to the factory as it involves operations which cannot be conveniently performed in the average garage.

As has been pointed out in other paragraphs, it is absolutely essential that the proper ratio of braking effort be held between the front and rear wheels.

Therefore, it is particularly important that the front brake shoes be lined with material of the proper qualities. It must also be properly applied and afterwards ground to make it conform to the drum.

In view of the nature of this operation and the fact that the shoes will seldom need relining, we therefore, recommend that they be sent to the factory to have this performed.

15-A—Forming the Brake Bands

In order to take advantage of every square inch of braking surface, the brake bands must conform accurately to the radius of the brake drum. Inefficient brakes are often due to the brake bands being sprung so that when applied, only a portion of their surface is actually in use.

The forming of the band can be quickly and accurately done by means of the fixture shown in Illus. No. 20. This special tool for rear wheel brake bands is described under C.O. 416 in Vol. 8. The fixture for parking brake bands is described under C.O. 418.

In removing the brake band, leave the bell crank attached. After removal, reassemble the helical spring and large adjusting nut.

Press the band together at points "B" and "C" (Illus. No. 20) to make it slightly oval in shape.

Clamp the forming fixture in a vise and slip the brake band over the large or small end, depending on which model is being worked on.

Tighten the nut "A" (Illus. No. 20) until the band is just a snug fit on the fixture.

With light blows of a hammer strike the band at all points around its circumference.

Remove the band and if it is still slightly distored, put it on the fixture again and repeat the above operation.

The diameter of the fixture is 1/32 of an inch greater than the diameter of the brake drum. The band will, therefore, be formed slightly oversize so that it will be impossible for the ends to bind in any way when assembled on the car.

16-A—Parking Brake Adjustment

Examine the brake band to see that it is round. If it is not, it will not conform to the shape of the brake drum and it will be impossible to adjust it properly. See "Forming the Brake Bands."

The parking brake band has three adjustments, one adjusting screw on the left hand side of the band and two adjusting nuts at the right-hand side. (Illus. No. 26).

To make the adjustment, turn the adjusting screw at the left-hand side of the band until the clearance between the brake band lining and the brake drum at this point is 1/32 of an inch. Turn the adjusting nuts below the large spring at the right-hand side to give the same clearance to the lower half of the band. Turning these nuts up loosens the band and turning them down tightens it. After making this adjustment be sure the lower nut is locked against the upper one.

Next turn the adjusting nut at the right-hand side of the upper half of the band to give the proper clearance. Make sure the clearance is now uniform and that the brake is not dragging. The rear axle should be jacked up and the clearance checked at all points with a 1/32 of an inch feeler gauge.

BODY

1-B—Roller Curtains

The roller curtains are carried in the top in brackets similar to the usual roller curtain brackets. These permit quick removal for repairs. See Operation Article No. 11.

The upper end of the curtain material has a metal edge which slides in a groove in the roller and is retained by crimping the edges of the groove.

To make repairs to the curtain material, remove the curtain roller and pull the material out of the groove.

Curtains should be installed so that they will not catch and remain in various midway positions but will have a continuous upward spring tension when in the downward position. See Operation Article No. 11.

If curtains are hard to fasten or unfasten examine the lower edge to see if the metal reinforcement is bent. Also inspect the bracket on the body which holds the overlapping portion of the curtains to see if it is bent too close to the body.

Issued June 1, 1929
Insert in Volume Two, after page 18

PRINTED IN U. S. A.

14-A-1—Brake Shoe Lining (Bendix 4-Wheel Brakes)

No attempt should be made to reline the brake shoes as the relining of these shoes requires special tools to apply and shape the lining to the shoe and drum.

Therefore, we advise you to install new shoes, sending the old ones in to the factory for credit less cost of relining.

16-A-1—Parking Brake

The parking (or emergency) brake is located on the propeller shaft immediately back of the transmission case. It is applied by means of a ratchet handle which is attached to the right side of the transmission case. The parking brake is applied independently of the service brakes and vice versa.

See Operation Article No. 37 to adjust the parking brake.

The parking brake and service brakes are the same except that when used as a parking brake they are applied by means of the ratchet handle which is attached to the right side of the transmission case and when used as service brakes by a foot pedal.

The parking brake has no adjustment other than the regular service brake adjustment.

17-A—Bendix—Perrot Control (Bendix 4-Wheel Brakes)

The Bendix Perrot Control is a method of operating the front wheel brakes by means of an articulated shaft. This type of control is positive in action because the brake cam is always mechanically connected to the brake rod.

The inner end of the control shaft is supported in a ball and slip joint, known as the 1000 Ball assembly, attached to the frame of the car or other convenient point. The outer end is attached by means of a universal joint to the brake cam, the brake rod is not affected by the spring action of the car.

18-A—Brake Shoe Anchor Pin (Bendix 4-Wheel Brakes)

Although this has been termed an adjustment, it is not one in the usual sense of the word. The anchor pin is made adjustable only to compensate for inequalities in the brake shoes and linings, and when once properly located should not again need to be changed except after replacing a set of brake shoes or reassembling an axle.

19-A—Equalizing the Brakes (Bendix 4-Wheel Brakes)

It is very important that the brakes be equalized at all times. This can be accomplished by pushing pedal down with a block or jack until tightest wheel can just be turned by hand. Slack off rod adjusting nut ½ turn at a time on the tightest wheels, until all four are the same, remembering that a change in the rear brake may effect the front brake on the same side and visa versa. Remove block from pedal and try all four wheels for drag. There should be no drag if previous operations were done properly.

20-A—Brake Shoes and Return Springs (Bendix 4-Wheel Brakes)

The shoes can be removed without being disassembled as follows: Detach the return springs, remove the nut or cotter pin from the secondary shoe anchor pin, and cotter key from the steady rest pin. Spread the primary and auxiliary shoes to clear the cam, drop shoes sufficiently to allow disengagement of articulating pin and eccentric and slip all the shoes off together.

The brake shoes are provided with two "return" springs the one holds the primary and auxiliary shoes against the cam, the other holding the secondary shoe against the eccentric adjustment.

These springs should be of sufficient strength to pull the shoes back and revolve the cam and lever back to their normal position.

The tension of these springs should be from 35 to 50 pounds at the extended length of the springs in place on the assembly.

2-B—Care of Body Locks and Hinges

Door dovetails and door lock strikers (bolt keepers) should be lubricated with a small amount of vaseline or graphite grease. Windshield hinge, door locks, lock bolts and hinge pins should be lubricated with 3 in 1 oil or a high grade lubricating oil.

To keep the door outside safety lock working smooth at all times it should be oiled with a few drops of 3 in 1 oil placed on the key just before it is inserted in the lock or use 3 in 1 oil in an atomizer.

3-B—Cause of Body Squeaks and Rattles

It is necessary to make an inspection of the following points when a body is being serviced for squeaks and rattles.

Inspect the body tie-down bolts, making sure

they are drawn down normally tight and see that shims are of sufficient thickness to insulate the body sill from the chassis frame. Examine the door lock strikers, dovetails and hinge pins for looseness or wear. Test the window glass for looseness and see that garnish moulding screws are tight. Glass loose in the channel will cause a very disagreeable noise.

Tighten all door hinge, floor board, instrument board or any other screws that might work loose.

4-B—Cleaning of Closed Car Upholstery

Too much care cannot be taken in cleaning the upholstery, as it is comparable to that which is used on the furniture in many of the finest homes and is easy to permanently stain or spot through the use of the wrong cleaning materials. In case of a general griminess, caused by a gradual accumulation of dust and dirt, a thorough cleaning of the trimming on the sides and top with a vacuum cleaner or brush will do much to brighten it up. This may be followed if necessary by a light wiping with a cloth dampened with cleaners naptha.

Note—Before starting to clean the upholstery remove the seats. The dust that is then brushed from the sides and top will settle on the seat boards and can be wiped up. Dust and grit are easily removed from the seats by beating lightly with a rattan carpet beater and brushed with a whisk broom. The cushions should be held up side down when they are beaten, so that all dust, will fall away from the upholstery.

Should the upholstery become spotted with grease, it can usually be removed by rubbing the spot lightly with a soft cloth dampened with any good cleaning fluid such as is used in removing stains from woolen or silk garments. As little rubbing should be done as possible starting well outside the area of the spot and then working with a circular motion toward the center.

Spots caused by water or spots from starchy or sugar substances such as candy, may be removed by using water or in extreme cases soap and water. When washed, rinse several times with a cloth dipped in clean water and wrung fairly dry.

In removing spots or stains from upholstery the pile of the fabric is generally distorted and flattened down in all directions. After dampened places have thoroughly dried, this condition may be corrected by steaming. If dry steam is available, the flattened spot should be liberally steamed from this source. If there is no dry steam available, wet a cloth, wring and apply to the surface and press lightly with a hot flatiron.

Steaming the fabric in this manner and rubbing lightly against the nap will raise the nap to its normal position and will assist in restoring the texture to its original state.

5-B—How To Clean Tops

A satisfactory method for cleaning a top that has become dirty and grimy is as follows:

Wash the top carefully with Ivory soap and water until dirt and dust have been removed. Then rinse off with clean water to remove any trace of the soap. If further attention is required a light coat of body wax can be applied to give the top material a glossy finish.

6-B—Body Colors Stenciled in Body

The name and symbol of the colors with which the bodies of present production are finished are stencilled in the body as follows: Trade name of the colors furnished above and below the belt moulding are stencilled on the rear seat board in the sedans and under the front seat in the victoria, coupes and roadsters.

7-B—How to Raise the Front Seat Cushion

While it is not practical to lower the front seat cushion to suit the driver, the cushion can be raised at a small expense of time and material by installing the four wooden strips as shown in (Illus. No. 11). President Eight Section.

8-B—Replacing the Windshield

If for any reason the windshield is removed from a closed car, care must be taken that all the old putty is removed and new putty used when it is replaced. See Operation Article No. 4 to remove and replace the windshield.

9-B—Hood Hinge Stops

Cars of present production are equipped with a hood support and stop designed to prevent the hood from folding back when in a raised position.

The installation of the hood support and stop can, if desired be installed on cars not so equipped. (See Illus. No. 20). President Eight Section.

10-B—Door Check Straps

A change was made in the door check straps in which a spring steel insert was incorporated in the strap to prevent any possibility of the straps kinking or breaking. The improved door check strap can be installed on cars when trouble is encountered at this point.

MISCELLANEOUS

1-C—Gabriel Snubbers

After the first 500 miles the Gabriel Snubbers used on the Big Six should be adjusted owing to the natural settling of the car springs and the slight thinning of the snubber belt where it is coiled upon itself. To make this adjustment refer to Operation Article No. 16.

Examine the snubbers after each 5000 miles usage and lubricate them if necessary. Remove the housing by taking out the cap screw in the side, then lubricate the stud in the main casting, the coil spring and the face of the sleeve casting well with graphite grease of a good quality. Do not put any grease between the coils of the belting except a little on the end of the belt where it is riveted to the brass friction band (Illus. No. 34). Replace the housing. Adjust the snubber according to Operation Article No. 16.

2-C—Watson Stabilators

Watson Stabilators should never be lubricated in any way as they work on the friction principle and oil would destroy their braking action.

Be sure the straps line up with the openings so they do not chafe.

Do not attempt to adjust Stabilator springs; consult the Stabilator distributor when this operation is necessary.

When jacking up the car never place the jack under the Stabilator axle brackets.

3-C—Wahl Spring Brakes

The spring brake used on the Standard Six is water-proof and dirt-proof and requires no adjustment whatever. Emphasis is laid on the fact that it *should never be lubricated* as there are no metal to metal bearing surfaces or contacts. It is self-adjusting and full efficiency is not obtained until the car has been driven far enough to thoroughly seat the brake band into the drum.

In case of apparent failure of the mechanism within the drum, the entire drum unit should be replaced and the defective one sent to the manufacturer for repairs.

In replacing an arm on a drum unit, be sure that the arm has the punch mark on the bolt end over the punch mark on the top of the rotor. Be sure that the felt gasket is properly placed over the bolt, between the cover and the arm. Then, after putting on the arm, tighten the lower nut as tight as it can possibly be turned. Then put on the lock nut and draw it down snug. The arrow on the arm must always point down.

Revised September 15, 1927
Insert in Volume Two, in place of original page 19.
PRINTED IN U. S. A.

MISCELLANEOUS

4-C—Monroe Hydraulic Shock Eliminators

Monroe Shock eliminators are of the single action type and control the car spring rebound only. They cushion the reaction of the compressed car springs by allowing a slow easy return of the springs to their normal position.

After a road shock when the car springs are compressed the eliminator arm is in its highest position. At this point the piston is also up and the cylinder is full of oil.

As the car springs force the body upward the arm comes down and since the arm and cam are integral the piston is forced down by the cam (See Illus. No. 12 President Eight Section). Resistance is immediately set up by compression of the oil and forcing it through the regulated orifice. The oil starts flowing through the piston orifice at high velocities, resulting in more or less resistance to the movement of the piston dependent on the size of the orifice. As the pressure increases oil passes out between the relief valve discs. As the speed of reaction increases, additional oil flows between the discs at a higher pressure thus maintaining a smooth giving resistance during the rebound stroke. Resistance is applied until the car body comes to rest.

5-C—Refilling with Oil

The eliminators should be refilled with Monroe cushion oil every 6,000 miles or every six months. To refill wipe off cover, remove the oil filler plug and fill with new oil.

Note—The arm should be moved up and down while refilling, to make sure that no air is left in the oil chamber.

6-C—Oil Leakage

Oil leakage seldom occurs but in case of excessive oil leakage around the arm gasket, the shock eliminator must be removed, disassembled and a new gasket installed. In case of leaks around the cover gasket or cover screws remove the cover and replace the gasket with a new one. If leaks occur around the acorn nut remove the nut and replace the copper asbestos gasket with a new one which is a standard 7/8" spark plug gasket. See Operation Article No. 16-2 to disassemble Monroe Shock Eliminators.

7-C—Valves and Sizes

The proper valves for use in the eliminators was determined after a series of exhaustive tests. Therefore, in case of complaint as to riding qualities or control of the car, first be sure that the car springs are properly lubricated, that spring shackles are free and well lubricated and that tires are properly inflated.

If, after checking the above point, springs are found to be excessively restricted by the eliminators, a change of valves may correct this condition. To increase control a valve of higher pressure or one of the same pressure but thicker discs may be used. Also a better balance between front and rear valves might be worked out. For less control the opposite procedure would apply. Valves may be ordered under the following part numbers.

Note—Under the heading "size" the first three figures indicate the thickness of the discs in thousandths of an inch. The last four figures indicate the capacity of the discs in pounds that is, the pressure at which the relief valve discs are set to operate.

Studebaker Part No.	Monroe Part No.	Valve Size
157899	170616	.016/600
157901	170716	.016/700
157900	170816	.016/800
157897	170916	.016/900
157895	171020	.020/1000
157798	171025	.025/1000
157896	171425	.025/1400

New shock eliminators will be furnished from service stock without valves, therefore when installing eliminators the valve assembly must also be installed.

8-C—Arm and Strap Length Adjustment

In replacing the shock eliminators or checking arm angles, the strap should be attached so that, with the car normally loaded, the end of the arm is about one inch below the line of the mounting studs. If installing a new strap allow approximately two inches below line of mounting studs which is to allow for stretching after car has been driven for a short time. Always make sure the strap clamps are tight and strap ends are accurately aligned.

If any cases of strap clamp slipping or strap breakage are encountered the improved strap clamp should be installed.

Issued June 1, 1929
Insert in Volume Two, after page 20
PRINTED IN U. S. A.

9-C—Noise

Noise from the shock eliminators is exceedingly unlikely. If a complaint of this character is made, first make sure that the eliminator is tight on the mounting and that all bracket bolts, clamps and axle bolts are tight. When testing for noise pull the arm down as far as it will go, releasing it suddenly. If the arm to axle strap is too long it is possible that the arm cam inside the case will strike the cover causing a solid thump or blow. Should there be any rattle or noise in the eliminator, remove the entire instrument, disassemble and inspect.

4-C-1—Lovejoy Hydraulic Shock Absorbers

Effective with Commander serial number 4066741 and Dictator serial number 1448517 Lovejoy shock absorbers replaced Monroe Shock eliminators.

The Lovejoy shock absorbers are of the single action type and control the car spring rebound by forcing oil through an orifice.

Their working principal and construction being very similar to that of the Monroe.

5-C-1—Refilling With Oil (Lovejoy)

The absorbers will only need refilling after a long period of service and the addition of oil should not be necessary more often than once a year or every 20,000 miles.

7-C-1—Valves and Sizes

Lovejoy shock absorbers are properly adjusted to give the best riding comfort when they leave the factory and should be left alone.

It is, of course, possible that you will run across an exceptional case in which the owner demands a change in the shock absorber control.

While we do not recommend a change from the factory setting, it is possible to change the adjustment of the shock absorbers by having the valves replaced at a Delco-Remy service station.

9-C-1—Noise

Noise from the absorbers is unlikely. However, in order to eliminate possibility of squeaks in Lovejoy Shock absorbers, a relief valve spring has been released and can be installed in cars if any case of difficulty of this nature is encountered.

TOLERANCE CHART

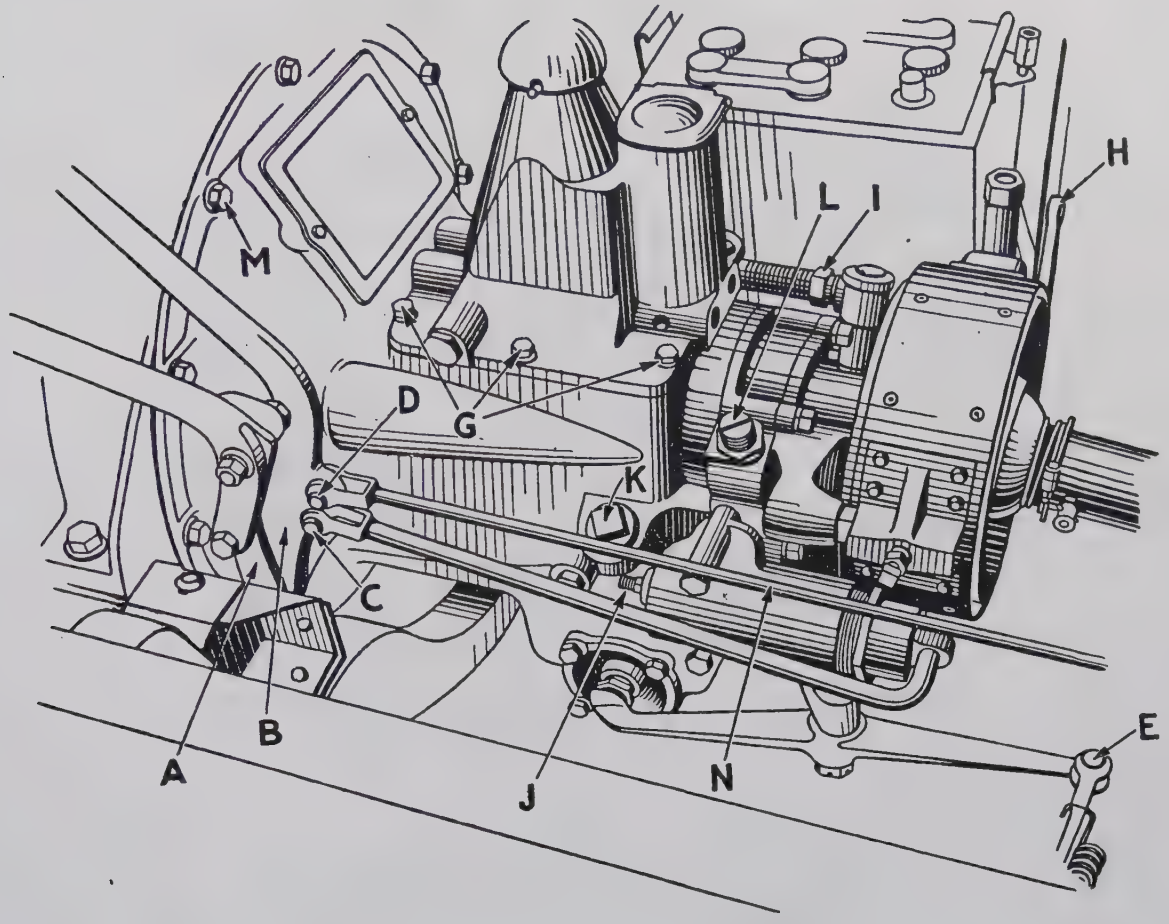
The chart on the following page is for your convenience in repair work. It will give you definite information as to the serviceability of parts subjected to wear and distortion.

Considerable judgment must be exercised in its use, however, and any decision based on this data must be tempered by individual conditions and the wishes of the car owner.

For example, the maximum clearance for the service brake pump piston is given as .010 of an inch. This means that, when overhauling the brake pump pistons having more than .010 of an inch clearance should be replaced to obtain a first class job. However, this is not to be interpreted as meaning that a piston with greater clearance is totally unfit for service. The thoroughness of overhaul as specified by the owner should determine this.

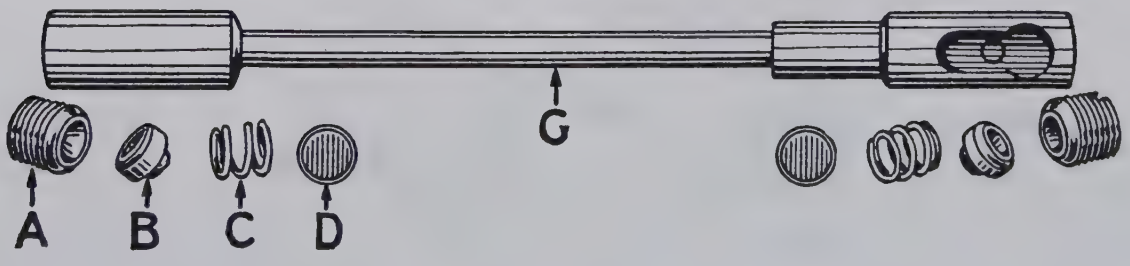
	Tolerance For New Parts		Tolerance For Parts In Service
	MIN.	MAX.	MAX.
Front Brake Long Lever			
Roundness	——	——	.008″
Clearance in bracket	.002½″	.005½″	.010″
Front Brake Shoe			
Clearance between lining and drum			
Hydraulic brake	.020″	.030″	——
Mechanical brake	.005″	.005″	.015″
Clearance of shoe pin in bushing	.002½″	.005½″	.010″
Roundness of shoe pin	——	——	.008″
Front Brake Drum			
Runout of face of drum	.000″	.015″	.020″
Front Brake Cam			
Clearance of shaft in support bushing	.002½″	.004½″	.010″
Roundness of shaft	——	——	.004″
Rear Brake Band			
Clearance between band and drum			
Hydraulic brake	.025″	.030″	.040″
Mechanical brake	.010″	.015″	.025″
Rear Brake Drum			
Runout of face of drum	.000″	.015″	.020″
Parking Brake Band			
Clearance between band and drum	.020″	.030″	.040″
Parking Brake Drum			
Runout at face of drum	.000″	.015″	.020″
Brake Pedal			
Clearance of shifter shaft in pedal arm	.0005″	.002½″	.008″
Clearance between under side of pedal pad and toe board			
Cars previous to Custom Models	5″	5″	5″
Custom Models	5½″	5½″	5½″
Clearance between pedal arm and under side of toe board	⅛″	¼″	¼″
Brake Pump Piston			
Clearance between piston and cylinder	.003″	.007″	.010″
Clearance of piston stem in cylinder cover	.0005″	.002½″	.005″
Roundness of piston stem	——	——	.003″
Brake Pump Gears			
Backlash between gears	.004″	.006″	.015″
Clearance of idler gear shaft in gear	.001″	.003″	.005″
Roundness of idler gear shaft	——	——	.002″
Service Brake Oil Pressure			
Pressure (with pistons blocked and engine running at speed equivalent to 30 miles per hour)	70 lbs.	75 lbs.	75 lbs.

ILLUSTRATIONS



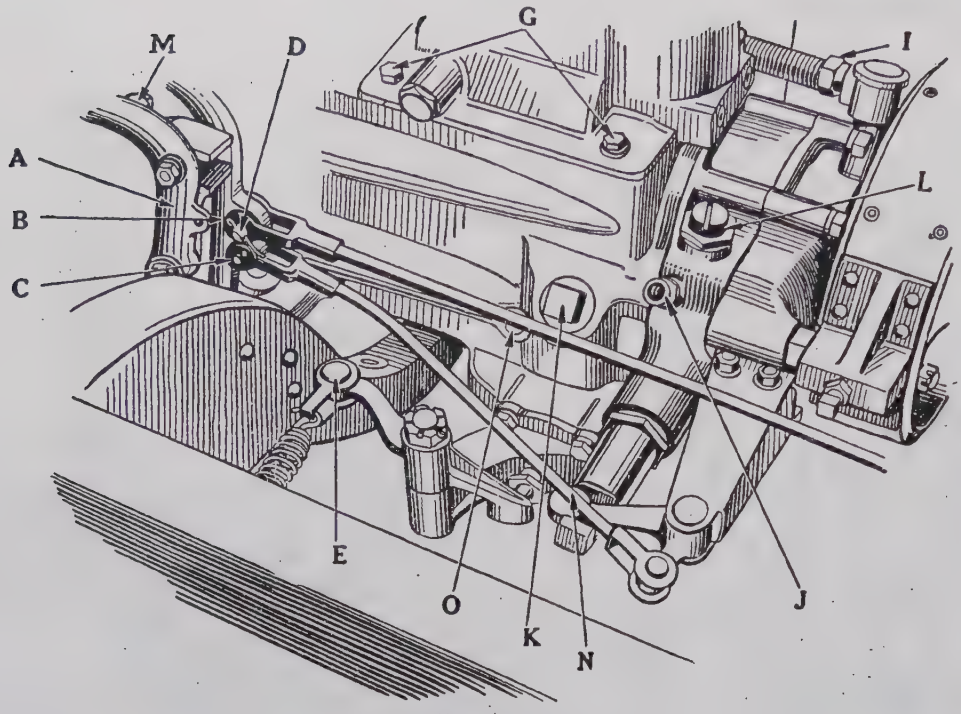
Illus. No. 1

Left-hand Side of Transmission Assembled in Chassis
(Big and Special Six Hydraulic Brakes)

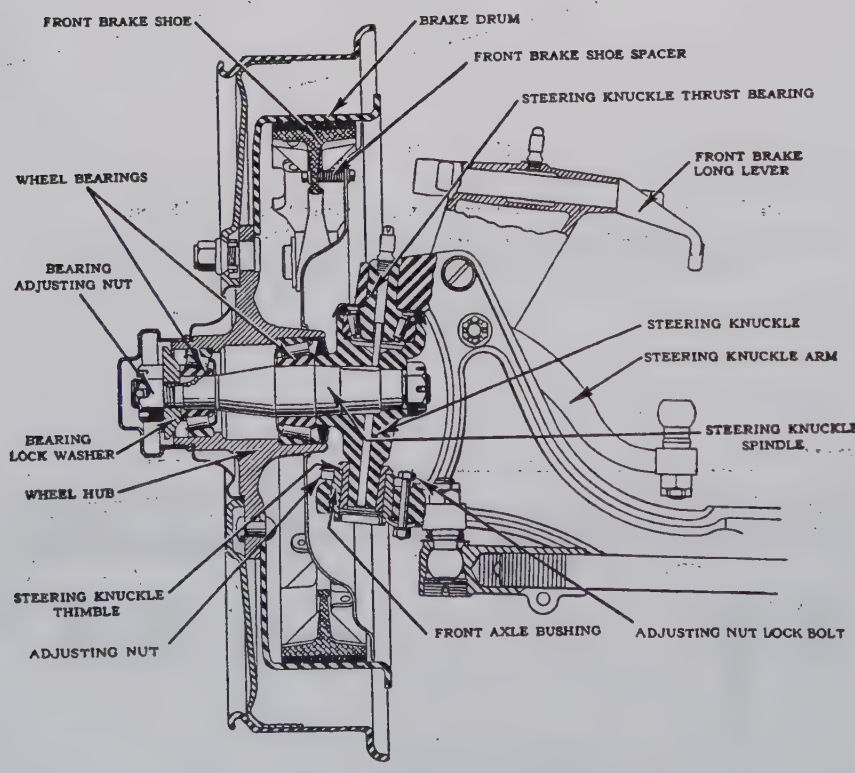


Illus. No. 2

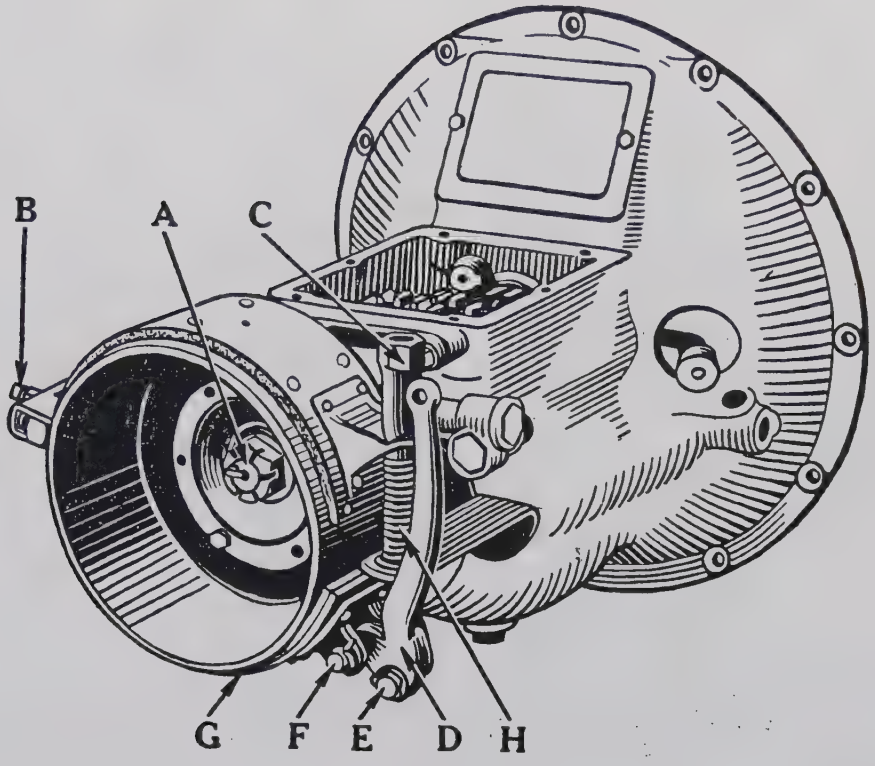
Front Brake Connecting Link



Illus. No. 3
Left-hand Side of Transmission Assembled in Chassis
(Standard Six Hydraulic Brakes)

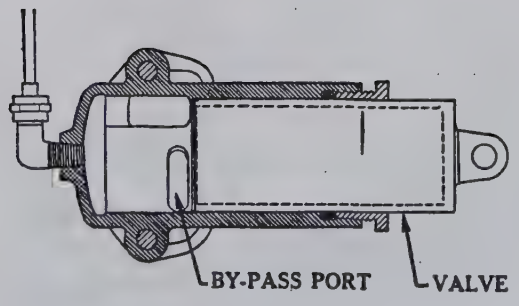


Illus. No. 4
Section Through Steering Knuckle



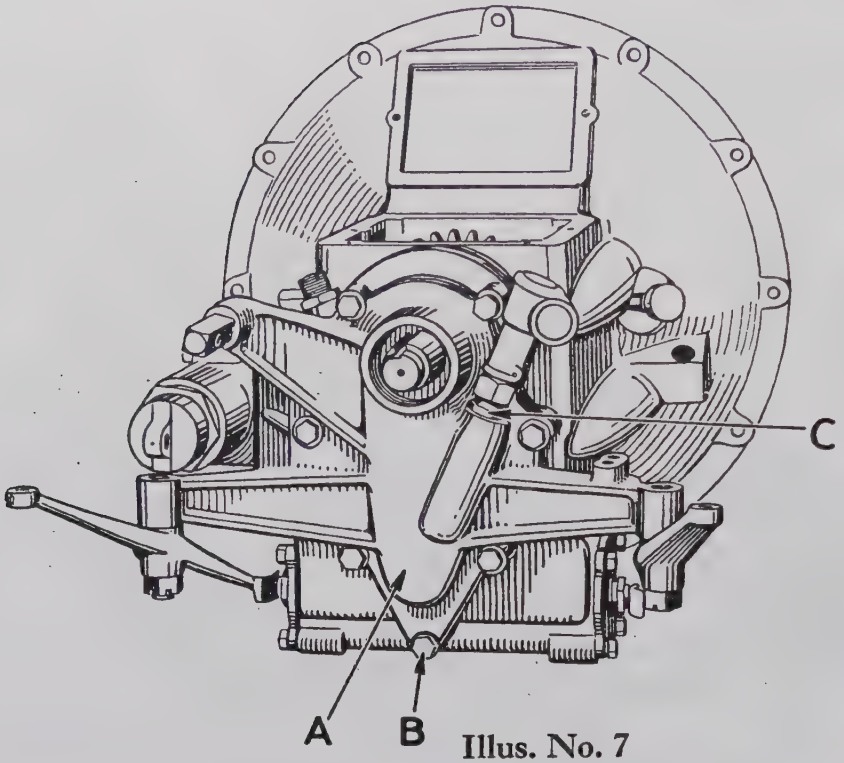
Illus. No. 5

Rear End of Transmission Assembly
(Big and Special Six Mechanical Brakes)



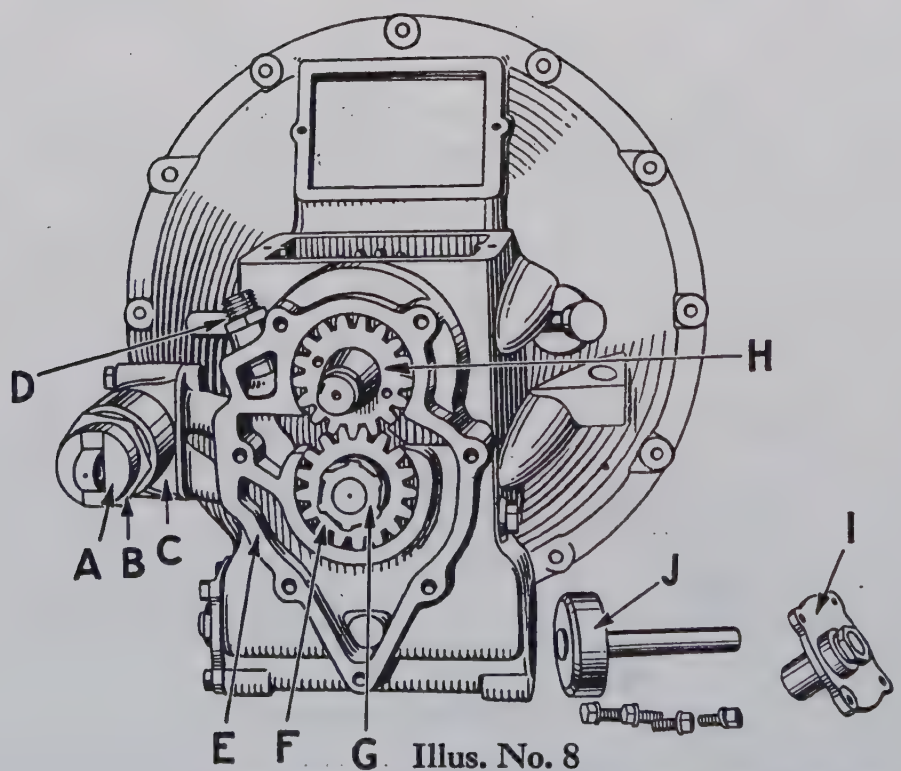
Illus. No. 6

Brake Pump Operating Valve



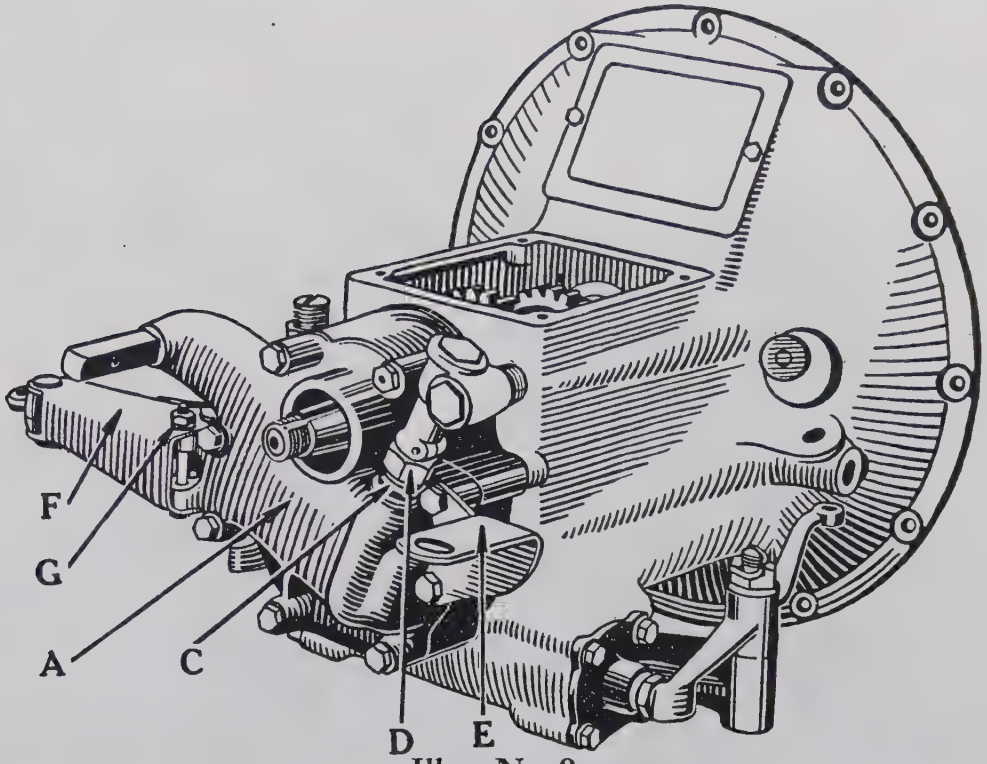
Illus. No. 7

Rear End of Transmission With Parking Brake Removed
(Big and Special Six Hydraulic Brakes)

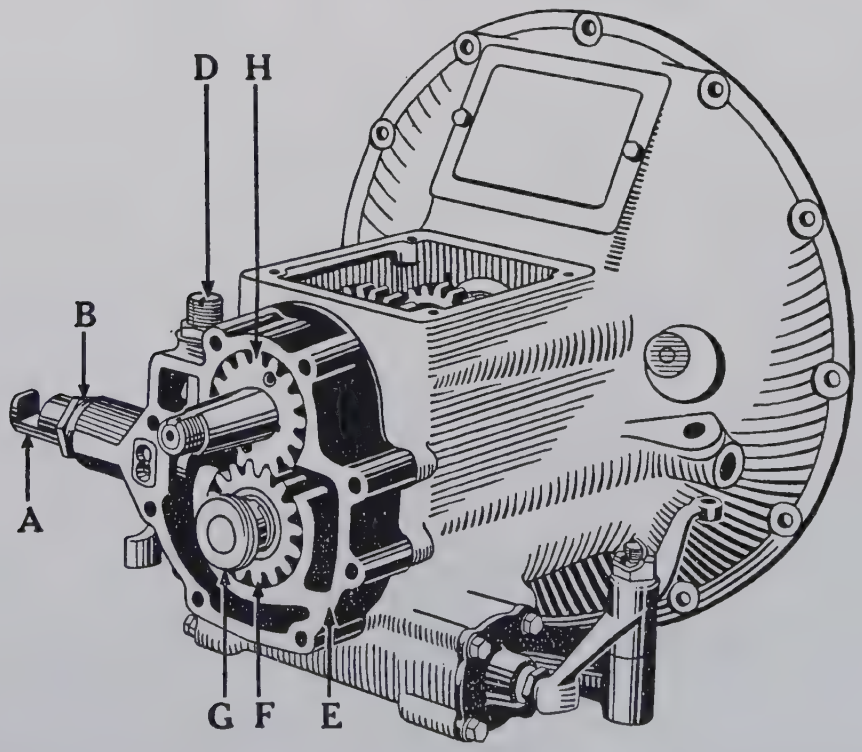


Illus. No. 8

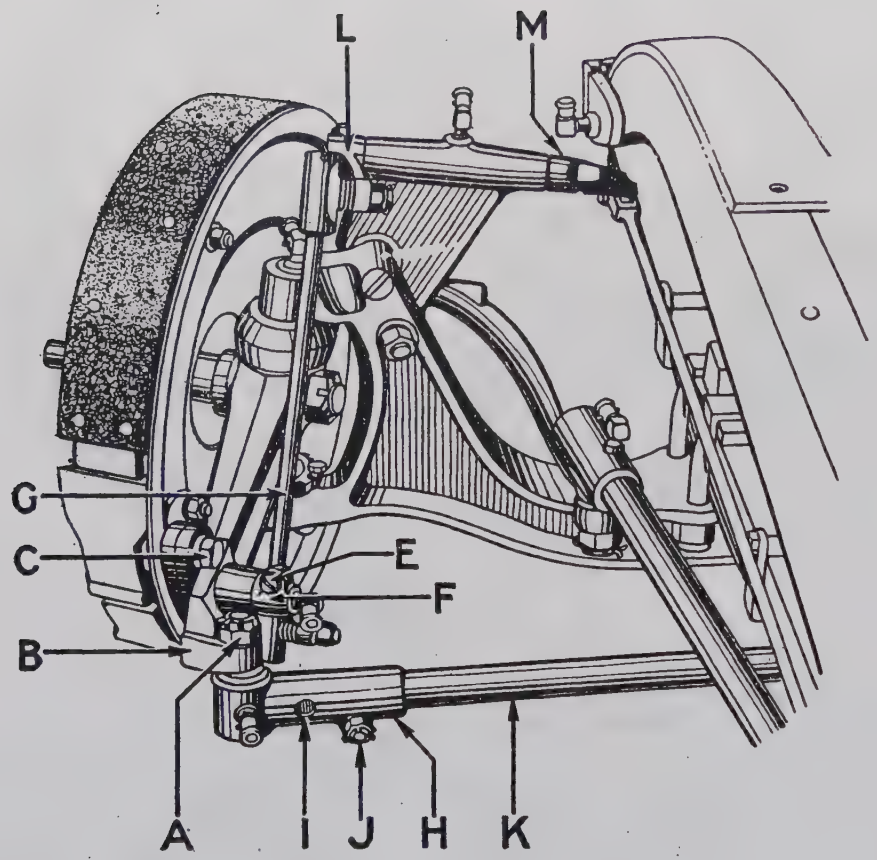
Rear End of Transmission With Service Brake Pump Cover Removed
(Big and Special Six Hydraulic Brakes)



Illus. No. 9
Rear End of Transmission With Parking Brake Removed
(Standard Six Hydraulic Brakes)

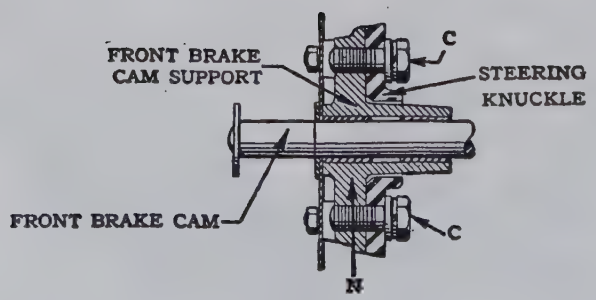


Illus. No. 10
Rear End of Transmission With Service Brake Pump Cover Removed
(Standard Six Hydraulic Brakes)



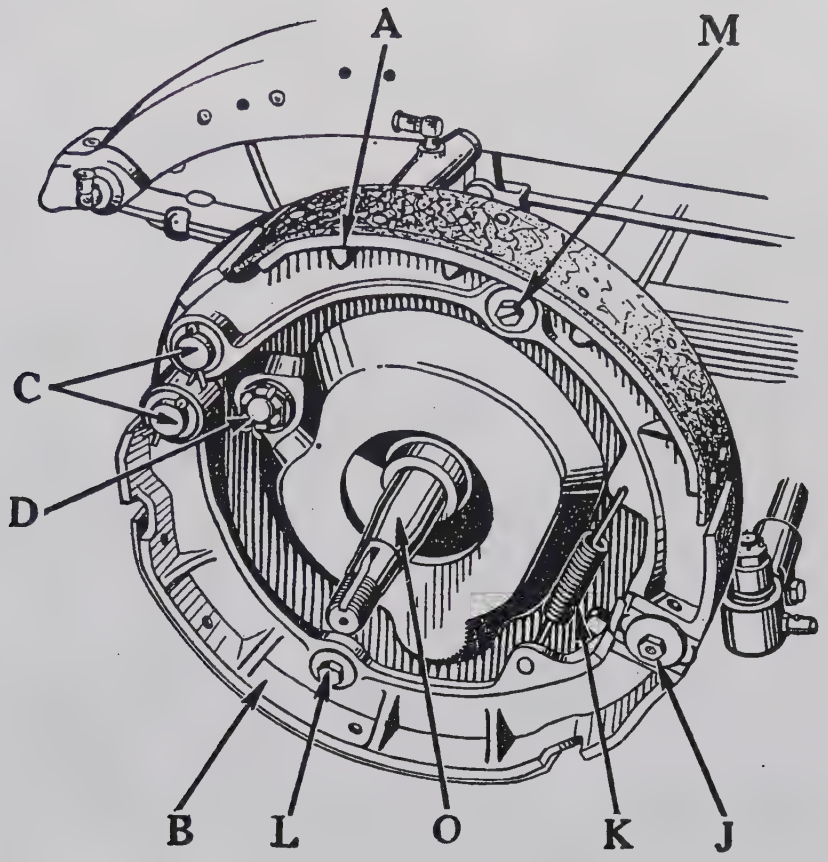
Illus. No. 11

Rear View of Left-hand End of Front Axle
(4-Wheel Brakes)

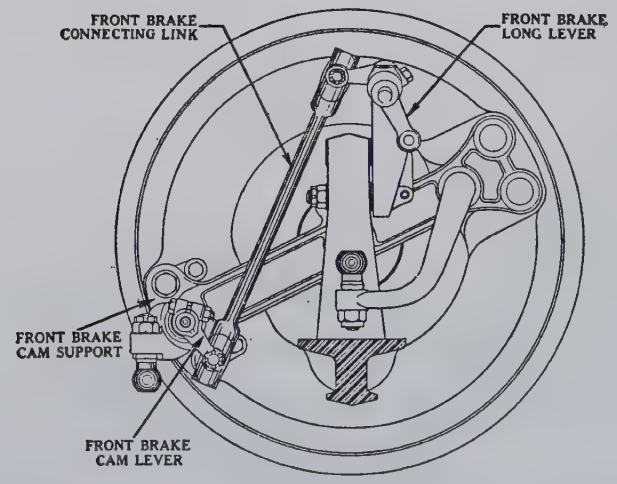


Illus. No. 12

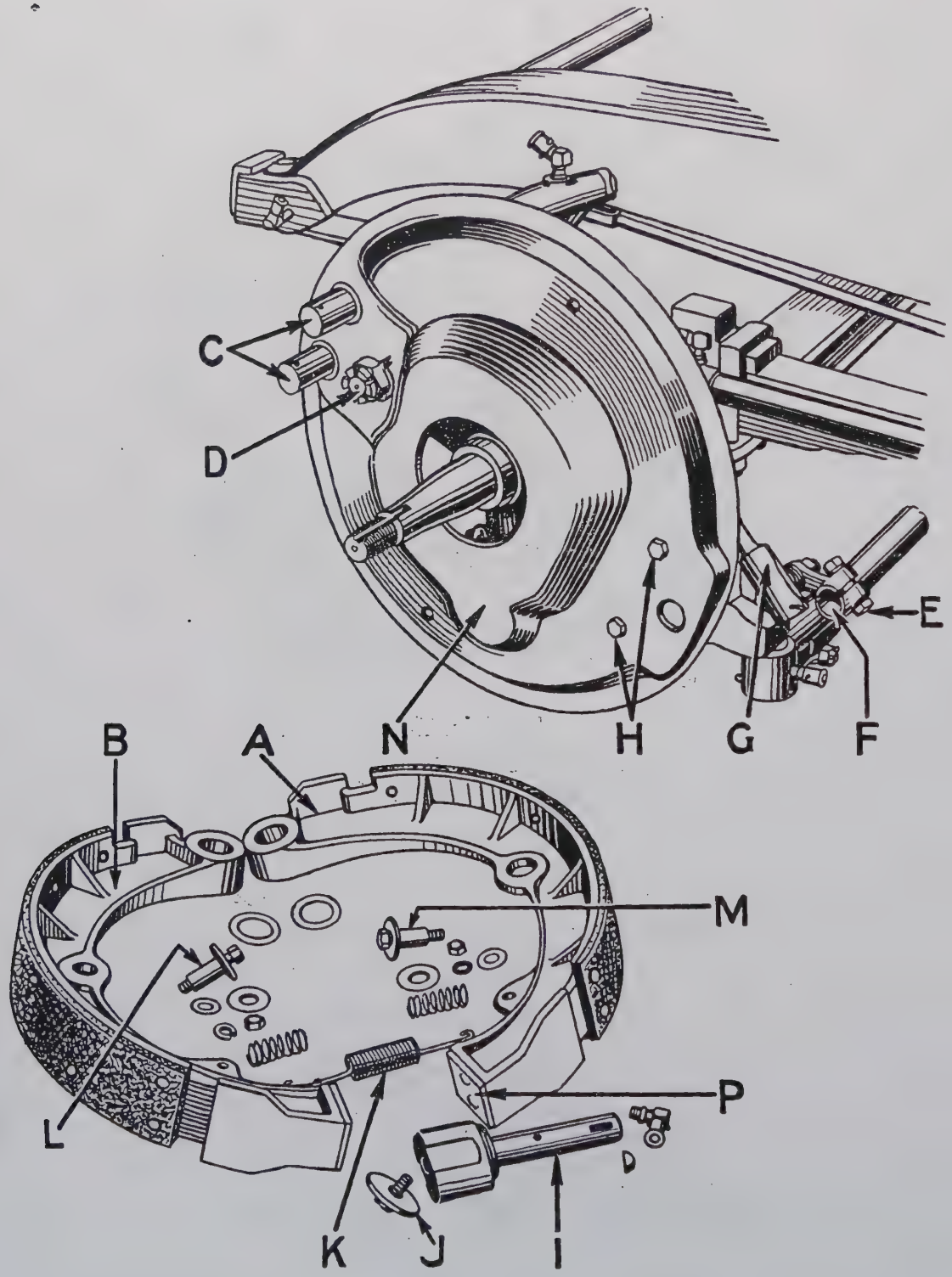
Front Brake Cam Support



Illus. No. 13
Front Wheel Brake Shoes

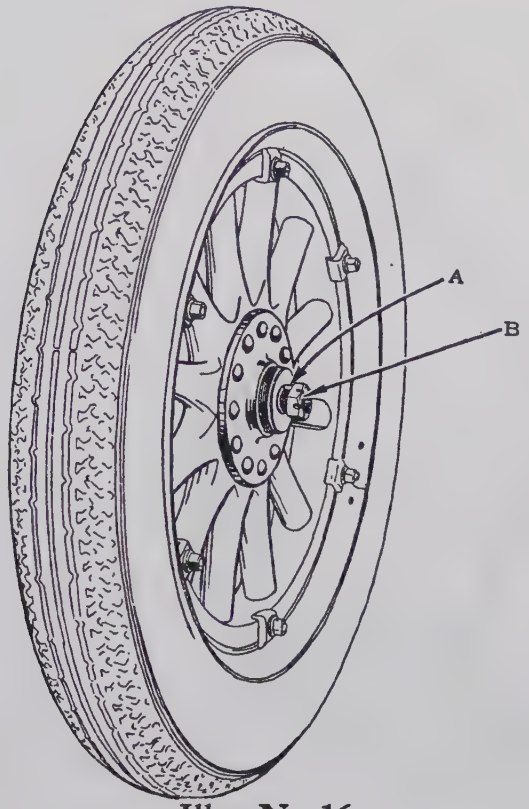


Illus. No. 14
Front Wheel Brake

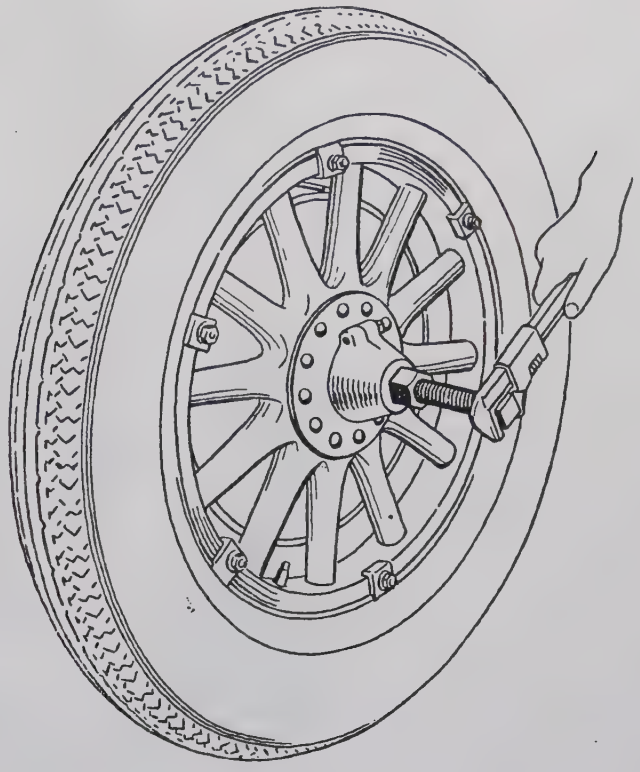


Illus. No. 15

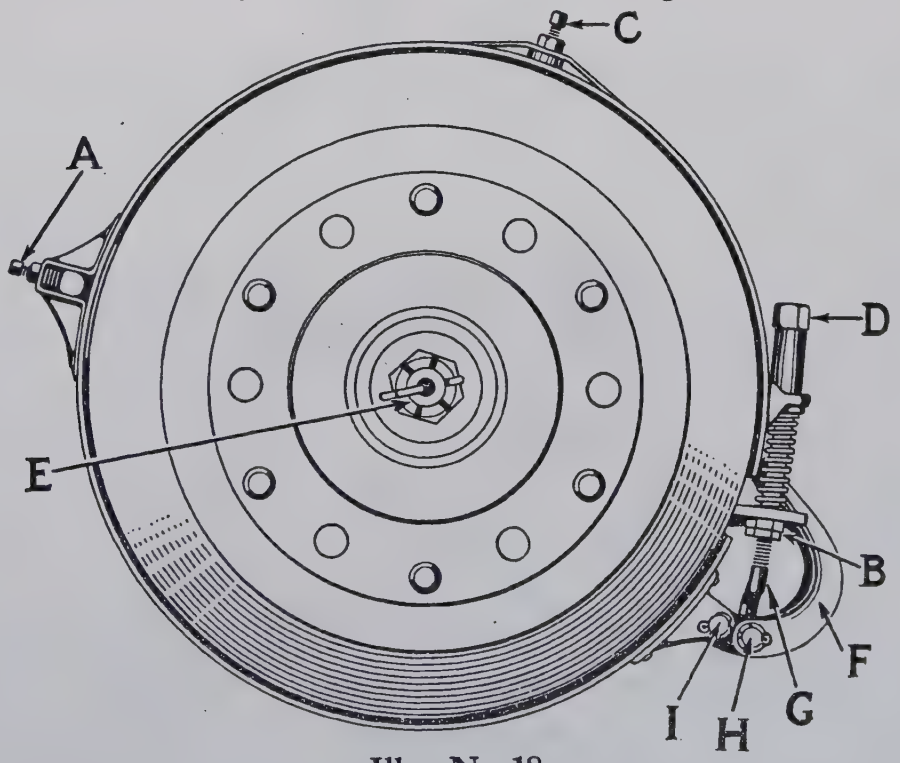
Front Wheel Brake Shoes Disassembled



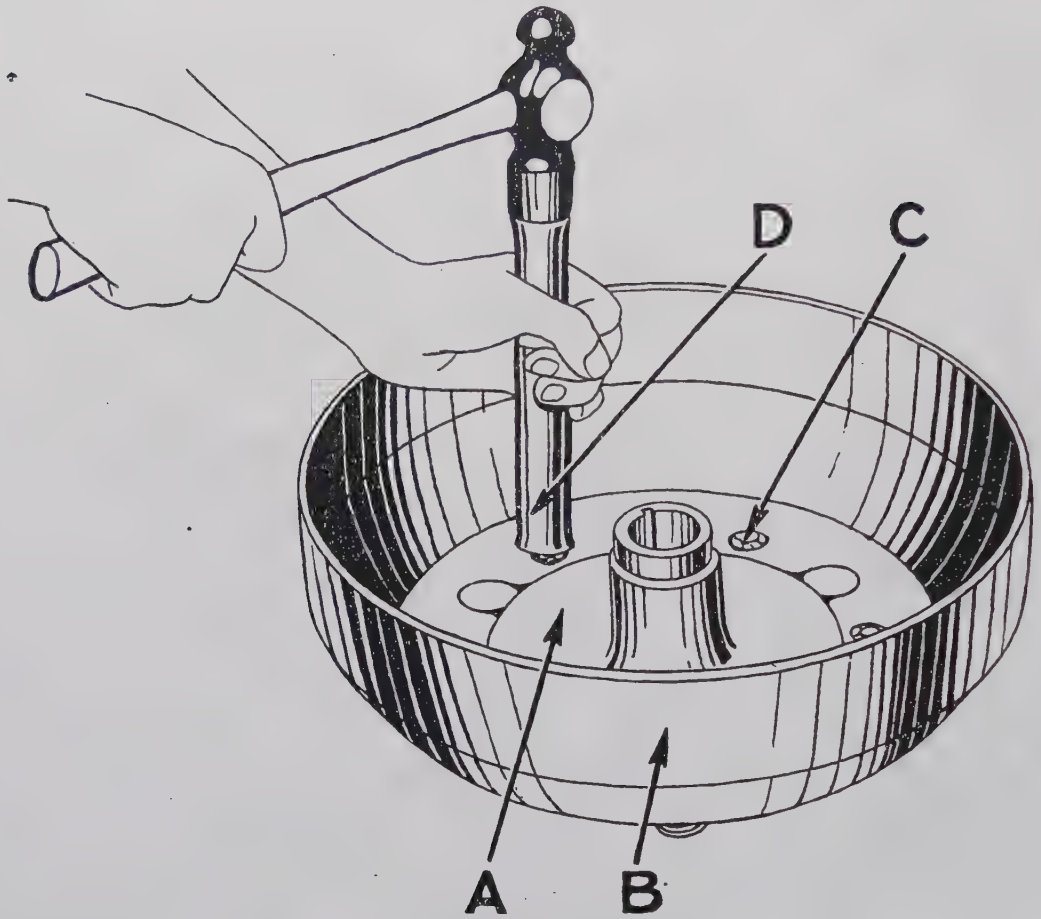
Illus. No. 16
Rear Axle Shaft Nut and Key



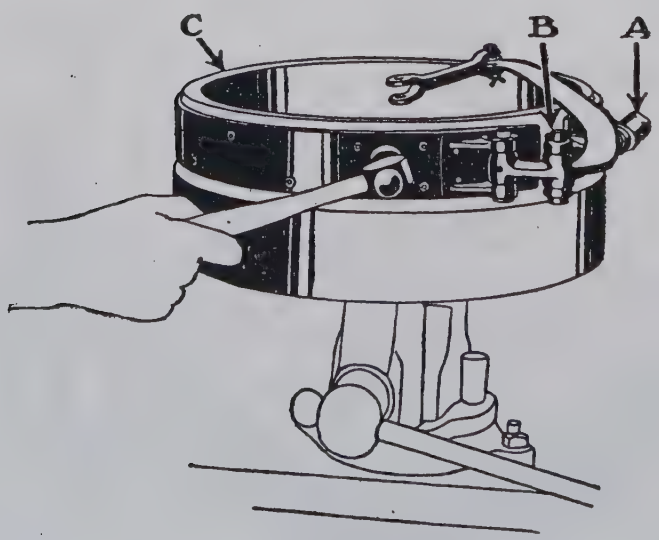
Illus. No. 17
Pulling Rear Wheel



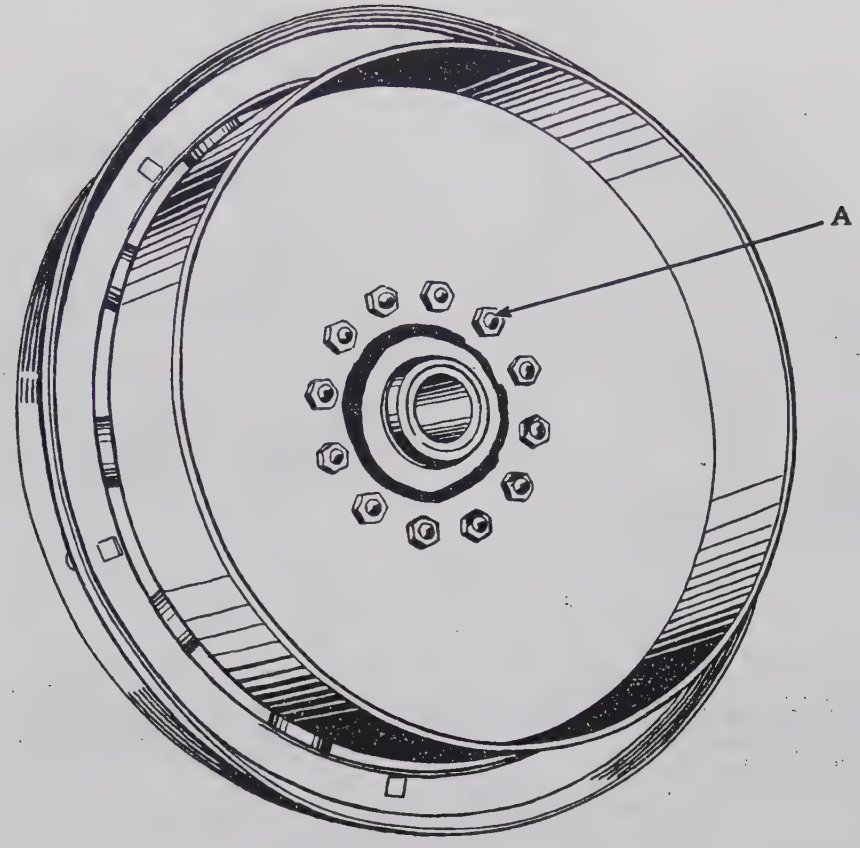
Illus. No. 18
Rear Wheel Brake Adjustments



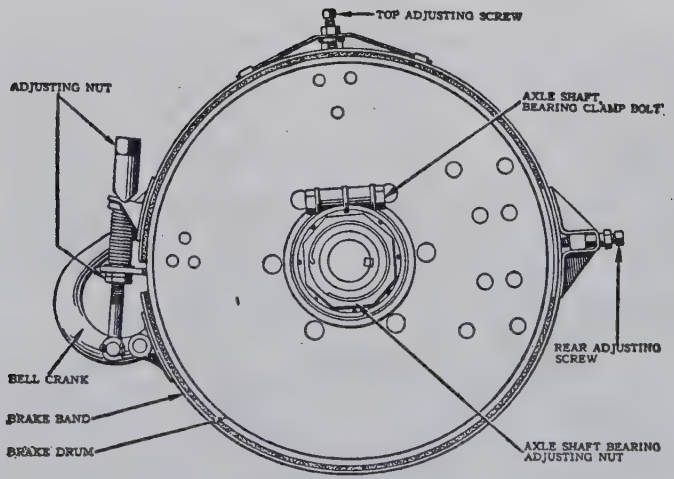
Illus. No. 19
Riveting Brake Drum to Disc Wheel Hub



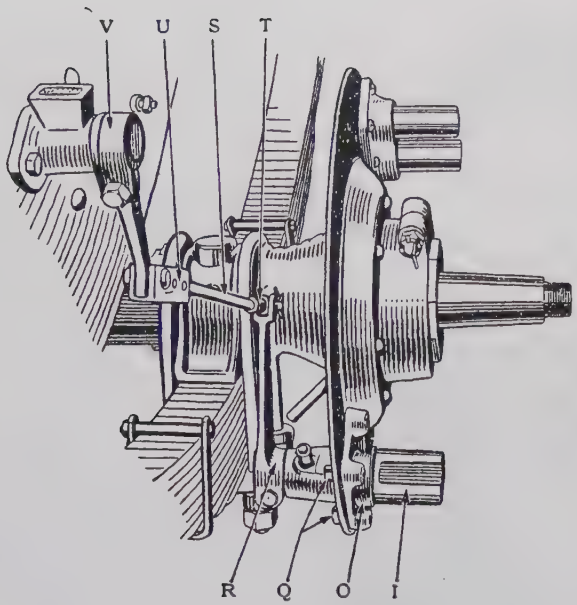
Illus. No. 20
Forming Brake Band



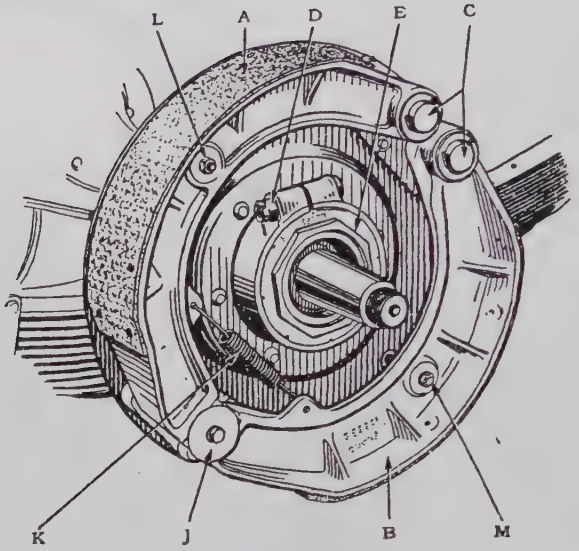
Illus. No. 21
Rear Wheel and Brake Drum



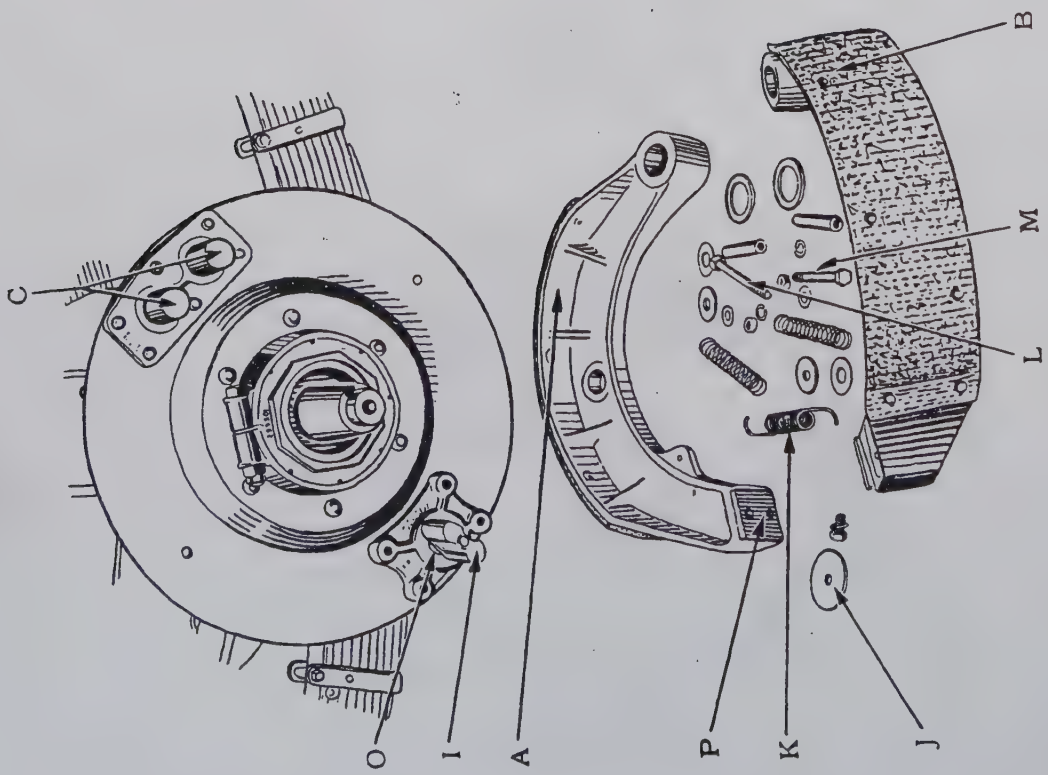
Illus. No. 22
Rear Wheel Brake



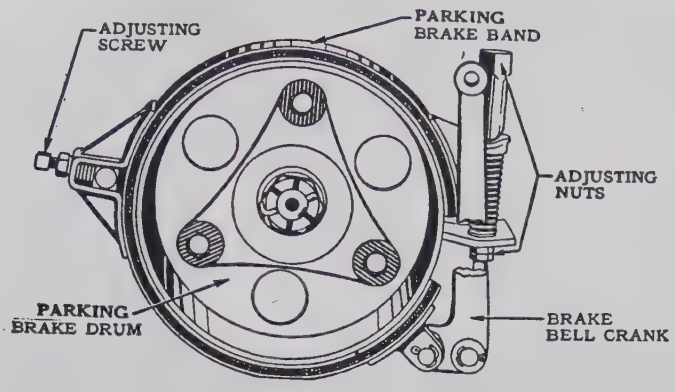
Illus. No. 23
Dual Wheel Brake Side Rods, Cam and Levers (Bus Chassis)



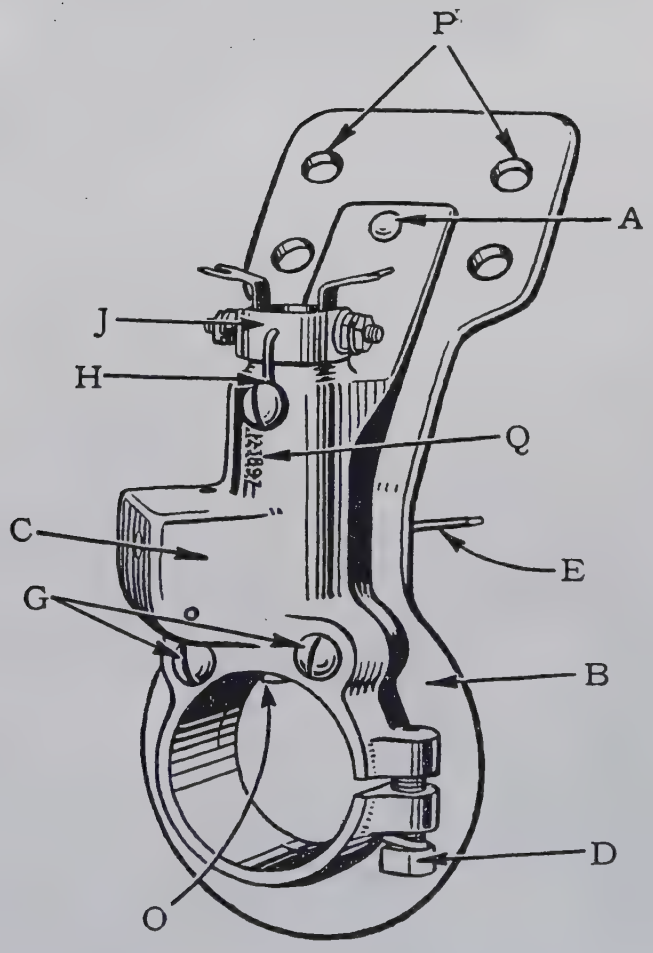
Illus. No. 24
Dual Wheel Brake Shoes (Bus Chassis)



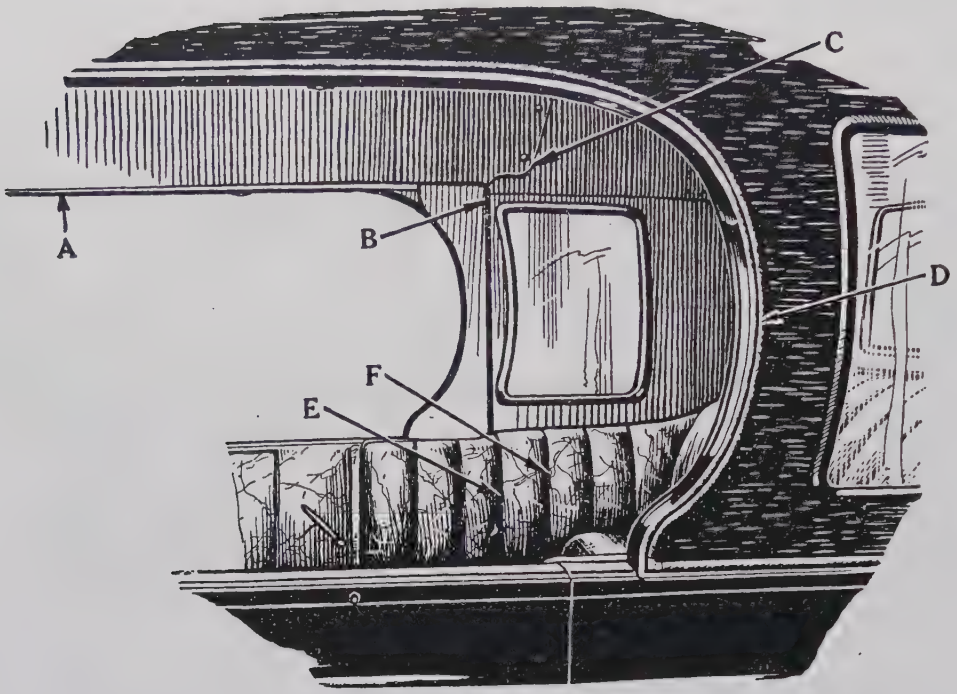
Illus. No. 25
Dual Wheel Brake Shoes—Disassembled (Bus Chassis)



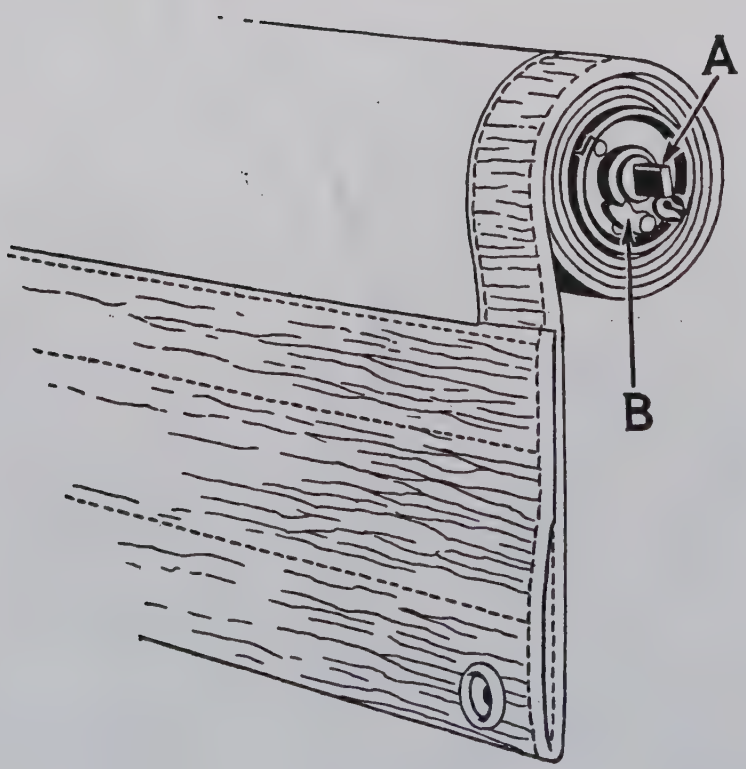
Illus. No. 26
Parking Brake



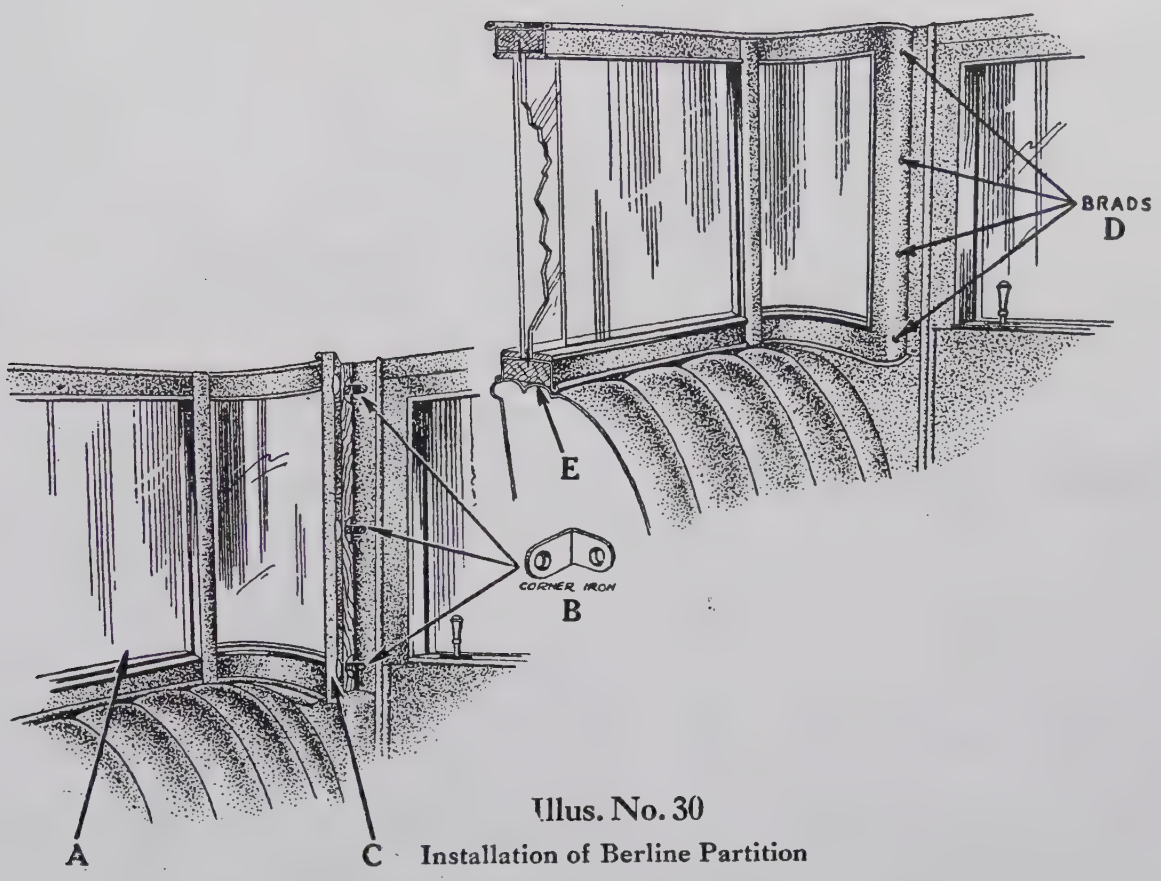
Illus. No. 27
Steering Gear Lock



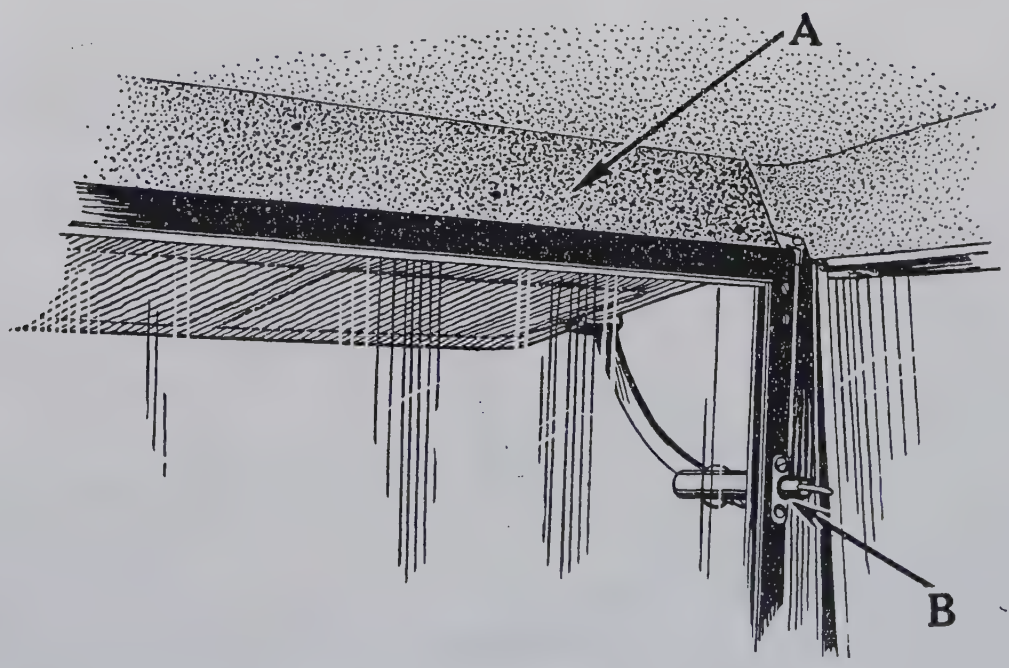
Illus. No. 28
Duplex Body



Illus. No. 29
Roller Curtain



Illus. No. 30
Installation of Berline Partition



Illus. No. 31
Front End of Duplex Body

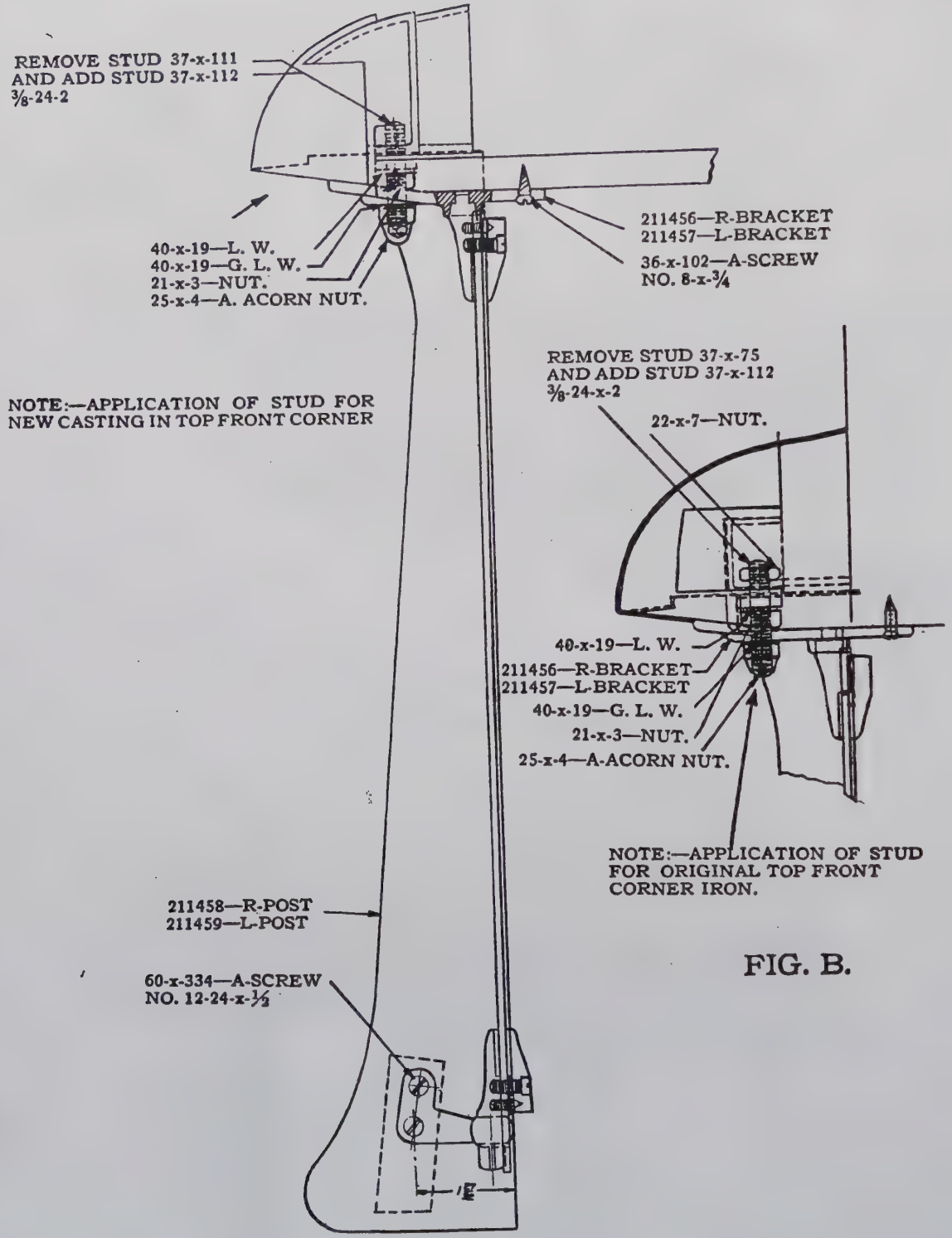
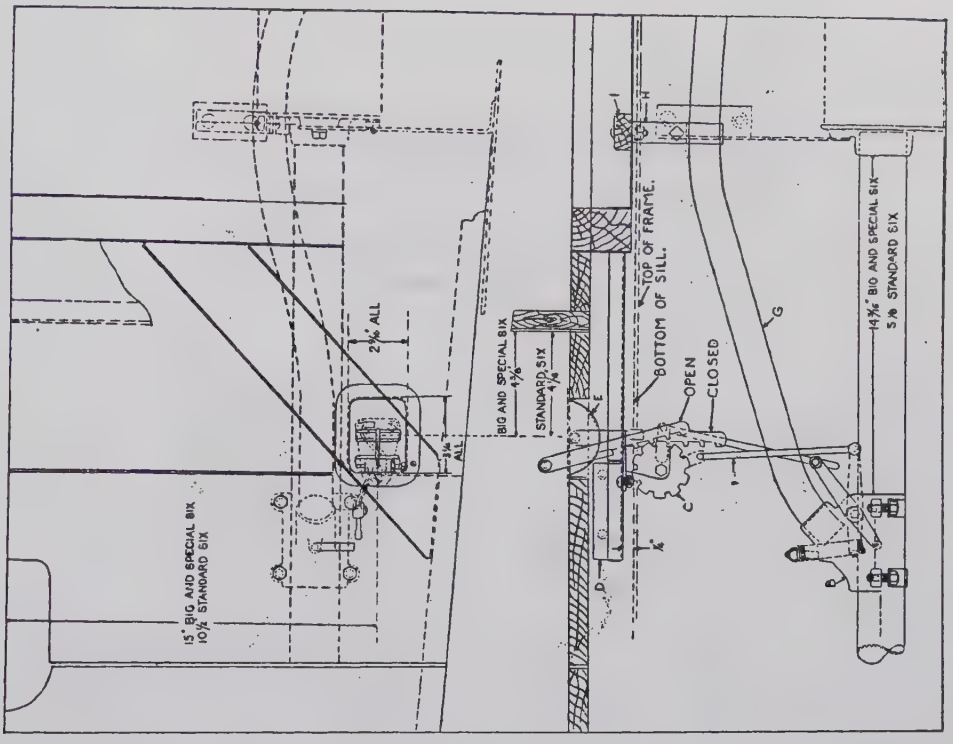


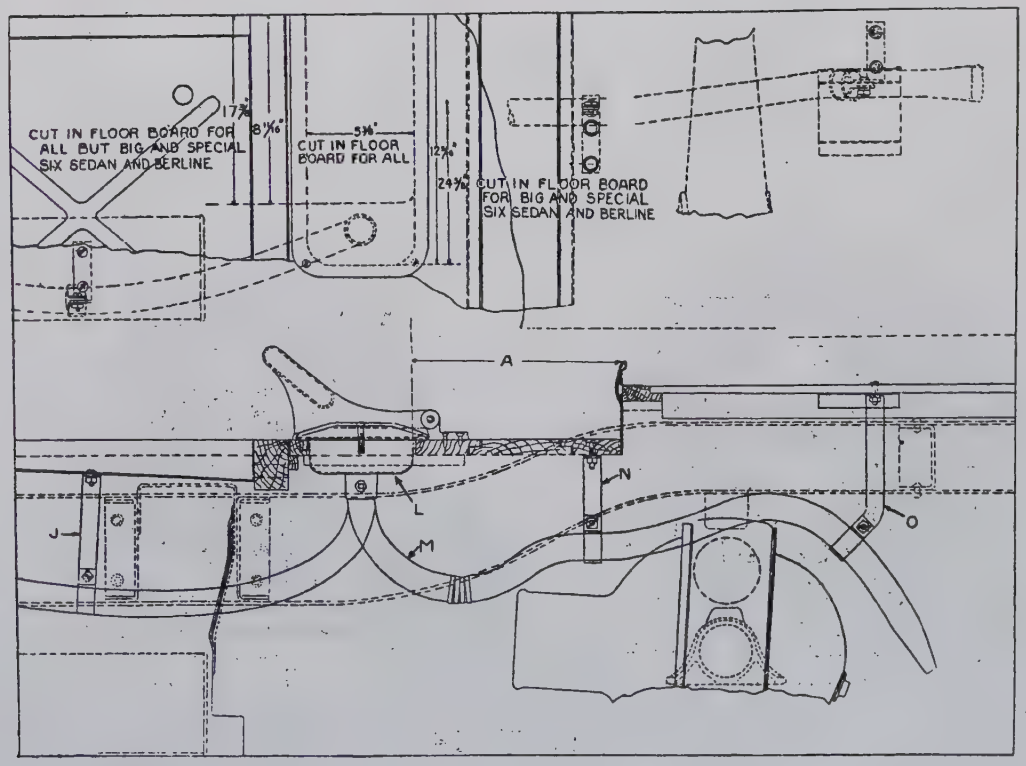
FIG. B.

FIG. A.

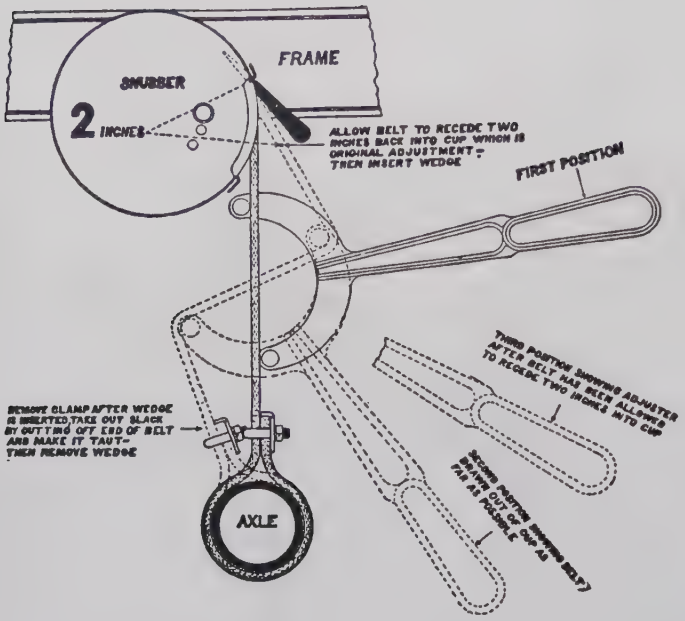
Illus. No. 32

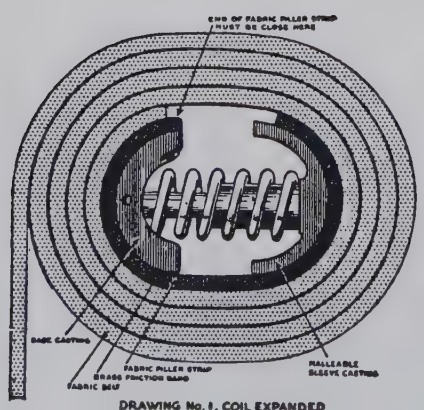
Installation of Windshield Side Wing Brackets on Duplex Models



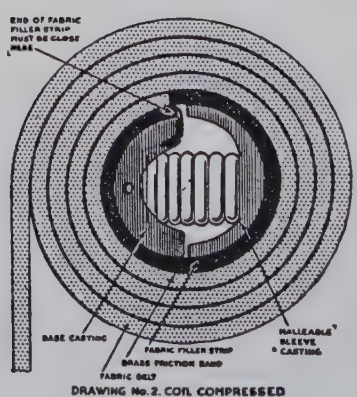


Illus. No. 33
Installation of Heater on Closed Cars


FRAME
SNUBBER
2 INCHES
ALLOW BELT TO RECEDE TWO INCHES BACK INTO CUP WHICH IS ORIGINAL ADJUSTMENT - THEN INSERT WEDGE
FIRST POSITION
THIRD POSITION SHOWING ADJUSTER AFTER BELT HAS BEEN ALLOWED TO RECEDE TWO INCHES INTO CUP
SECOND POSITION SHOWING BELT PAR AS POSSIBLE
REMOVE CLAMP AFTER WEDGE IS INSERTED, TAKE OUT SLACK BY CUTTING OFF END OF BELT AND MAKE IT TAUT - THEN REMOVE WEDGE
AXLE



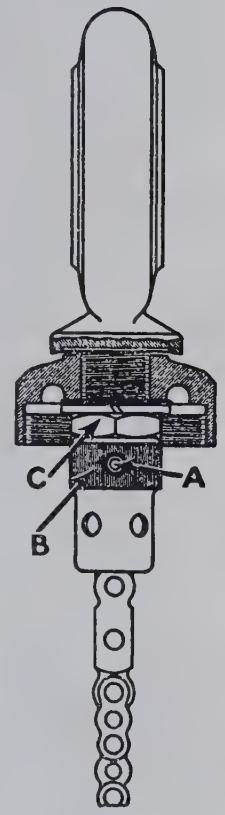
DRAWING No. 1. COIL EXPANDED



DRAWING No. 2. COIL COMPRESSED

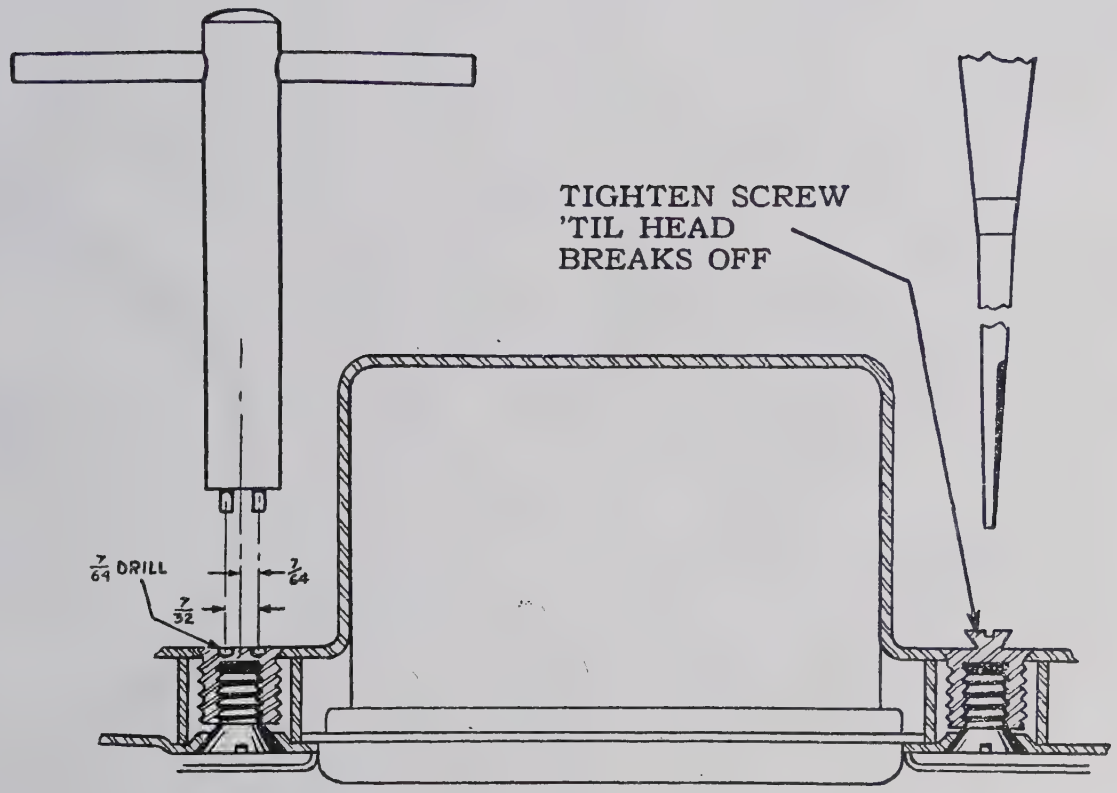
Illus. No. 34

Gabriel Snubber Adjustment and Lubrication



Illus. No. 35

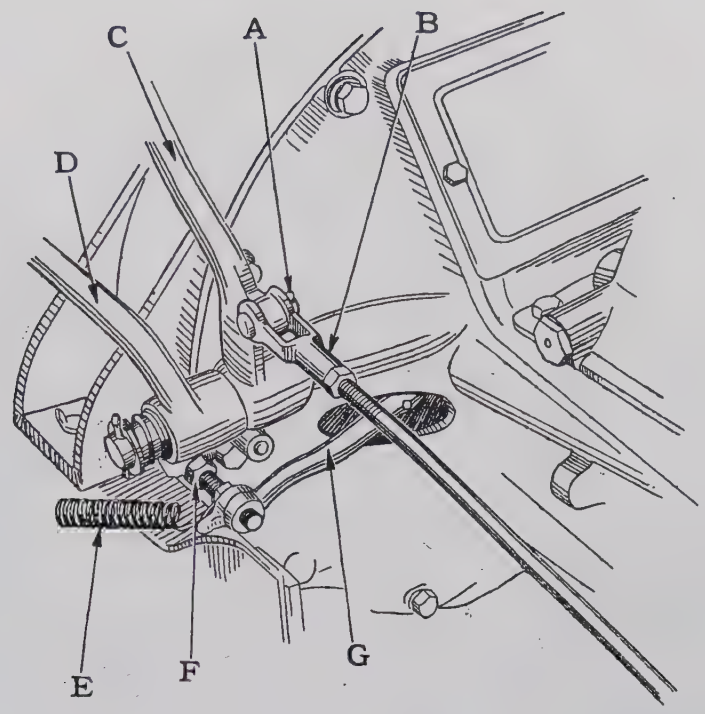
Motometer and Lock Assembled in Radiator Cap



Illus. No. 36

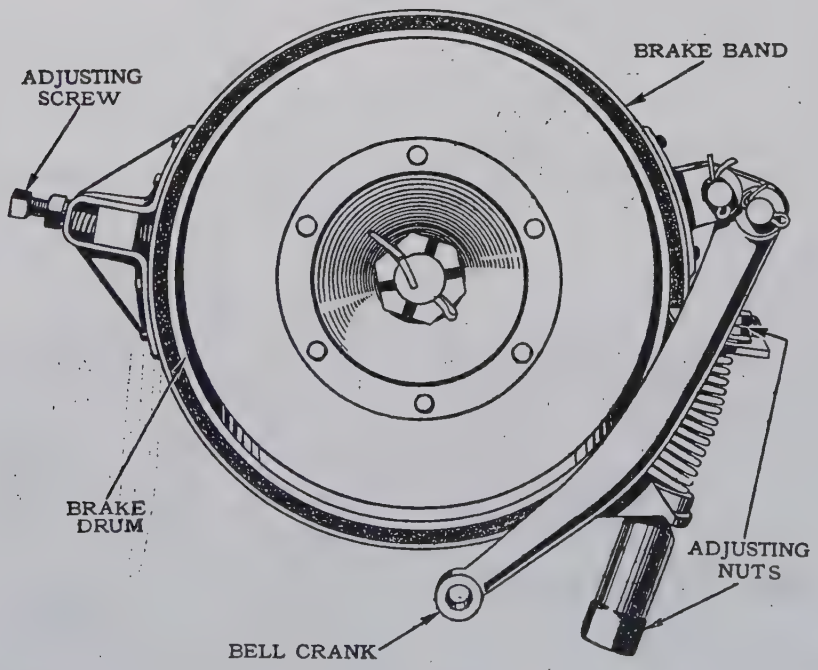
Removing and Replacing Clock Fastening Screws

Issued September 15, 1927
Insert in Volume Two, after page 46.



Illus. No. 37

Clutch and Brake Pedal Adjustments
(Big and Standard Six Mechanical 4-Wheel Brakes)



Illus. No. 38

Parking Brake
(Big and Standard Six)

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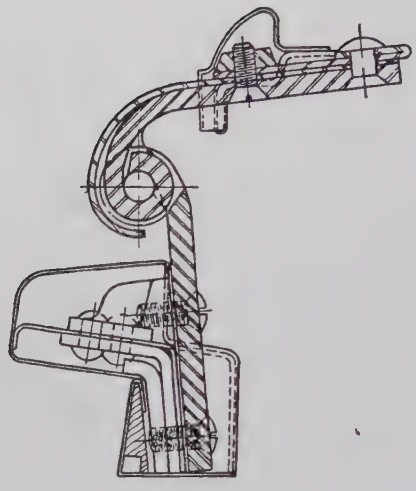
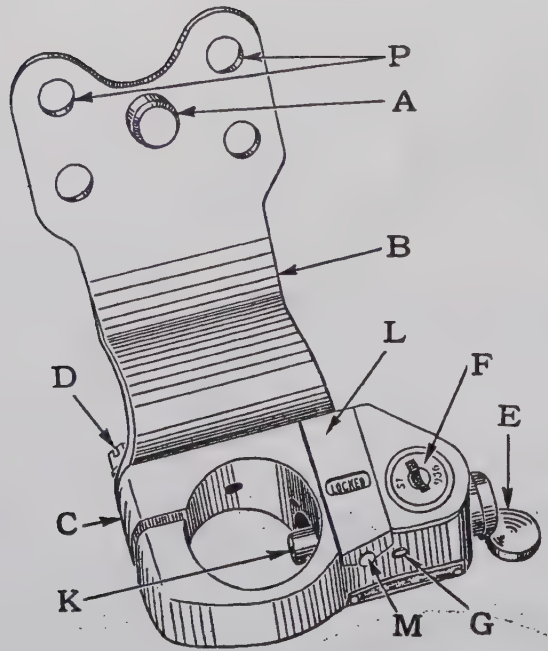
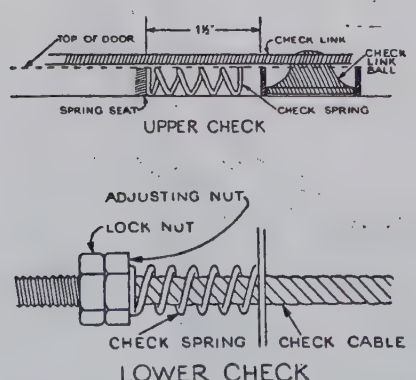


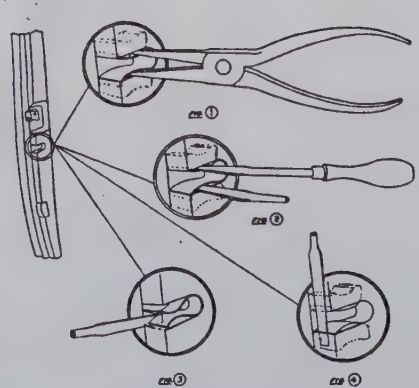
Illus. No. 39
Custom Body Door Hinges



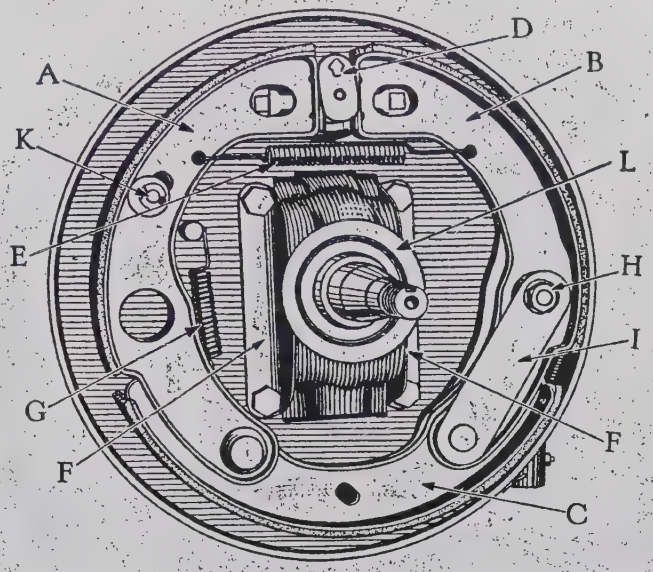
Illus. No. 40
Steering Gear Lock
(Ignition Switch Type)



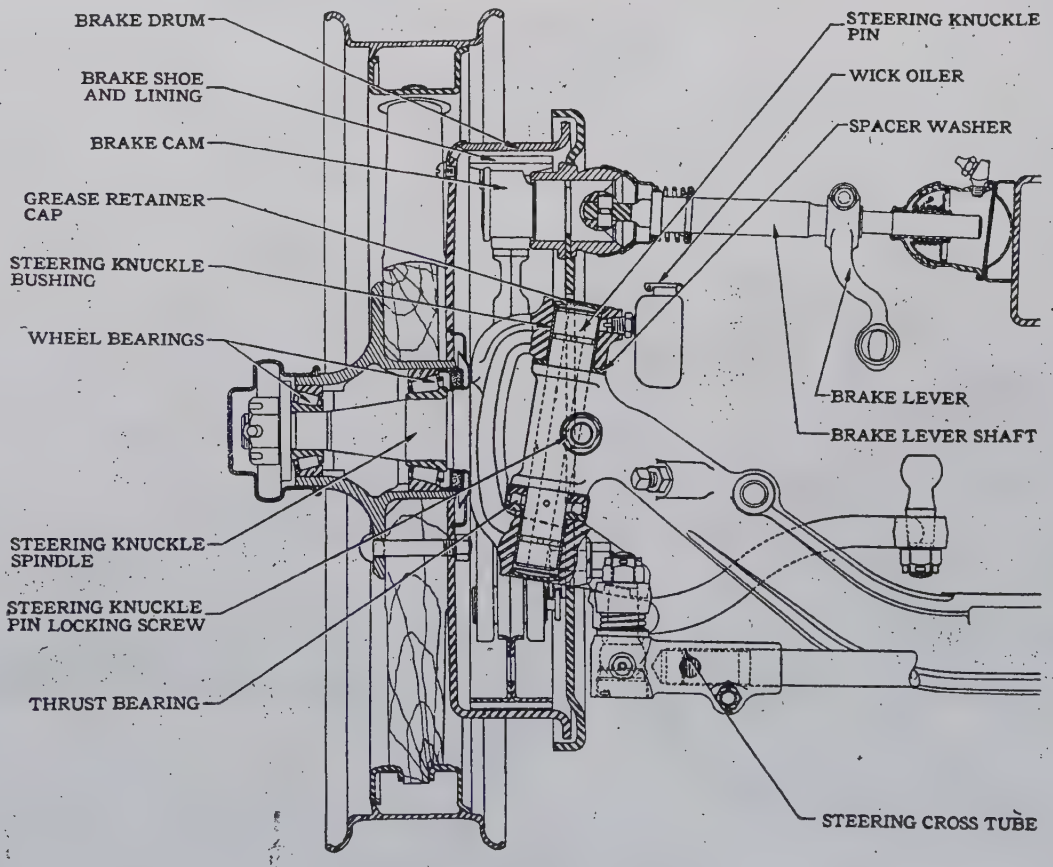
Illus. No. 41
Custom Body Door Checks



Illus. No. 42
Custom Body Door Dove Tails

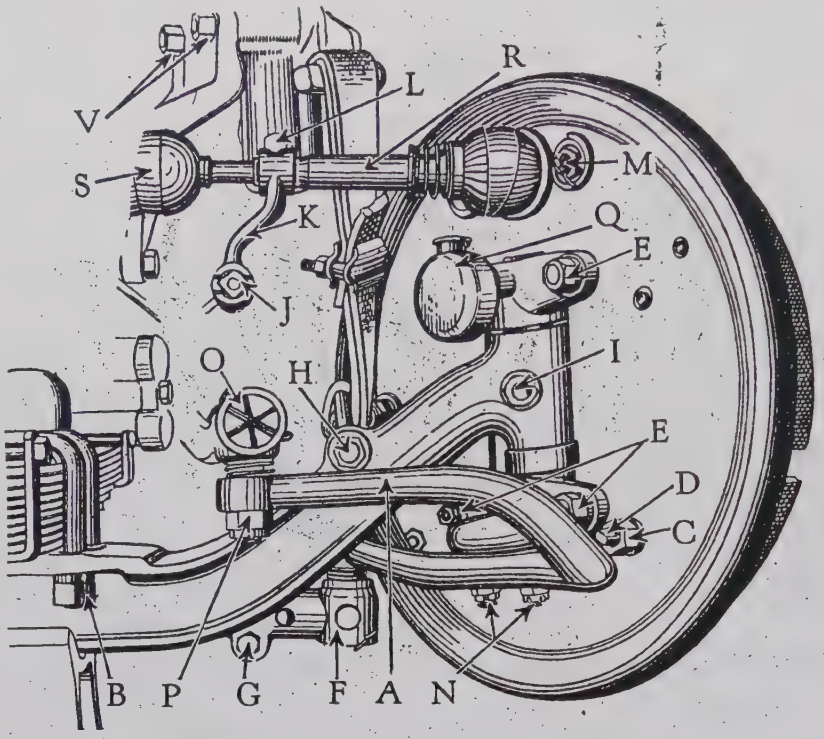


Illus. No. 43
Front Wheel Brake Assembly (Commander)



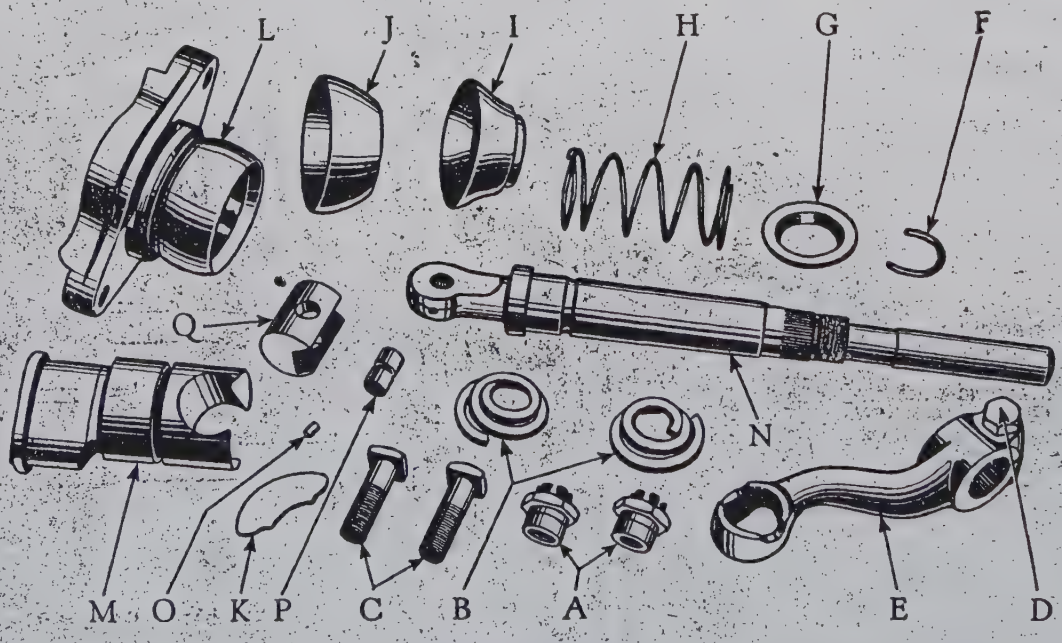
Illus. No. 44
Section Through Steering Knuckle (Commander)

Issued June 1, 1929
Insert in Volume Two, after page 46-B
PRINTED IN U. S. A.



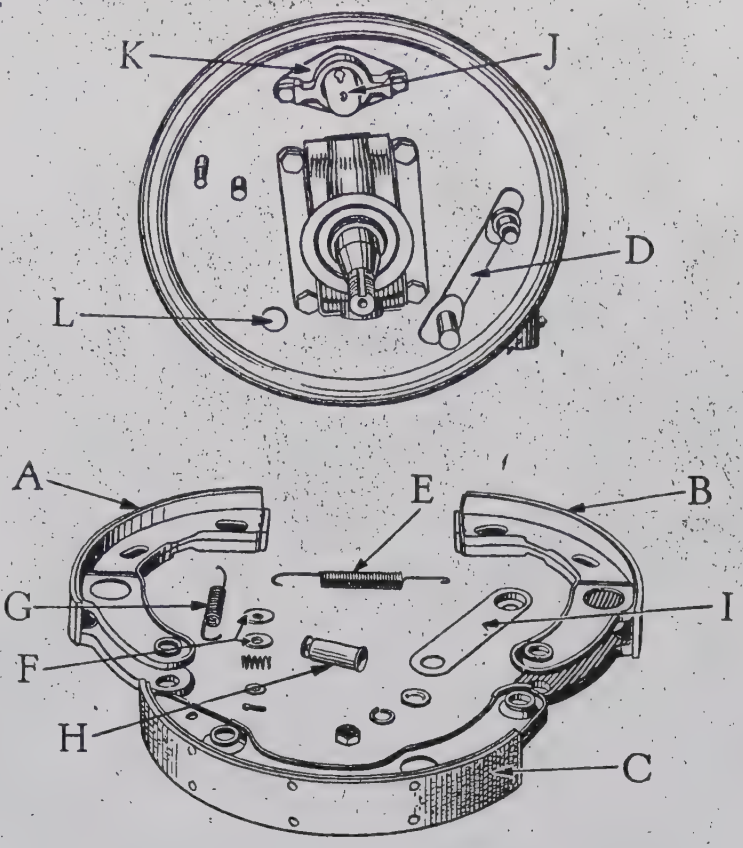
Illus. No. 45

Front View of Left-Hand End of Front Axle (Commander)

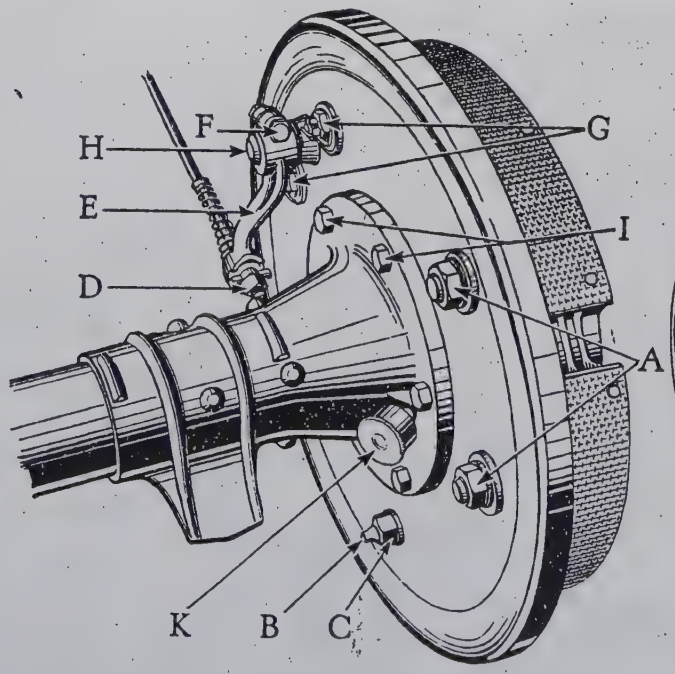


Illus. No. 46

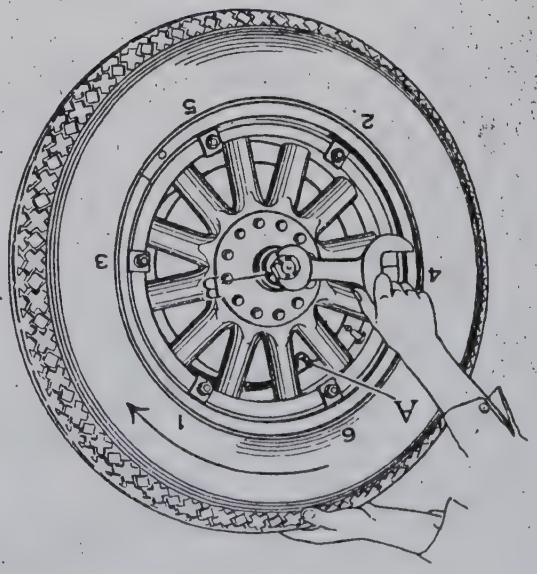
Front Wheel Brake Perrot Control Disassembled



Illus. No. 47
Front Wheel Brake Disassembled (Commander)

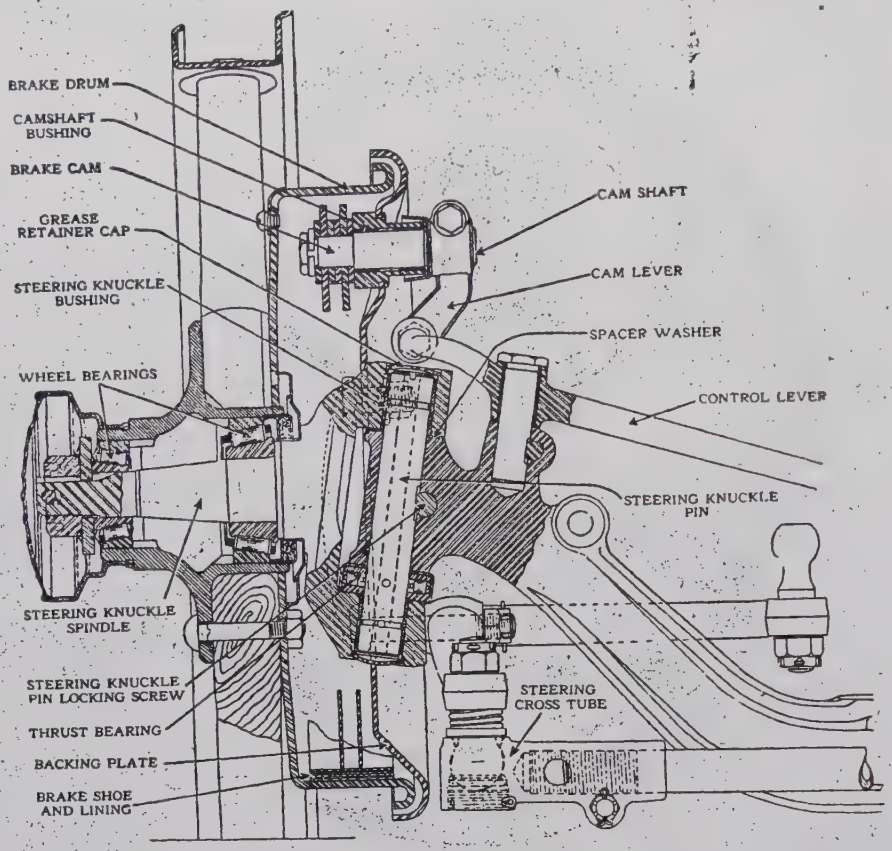


Illus. No. 48
Rear Brake Adjustment

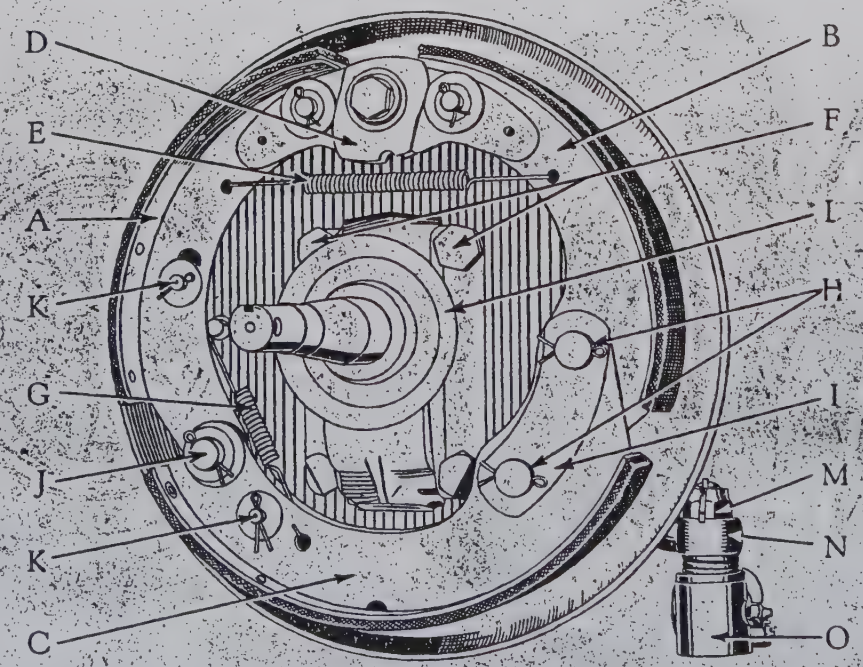


Illus. No. 49
Tightening Front Wheel Bearings

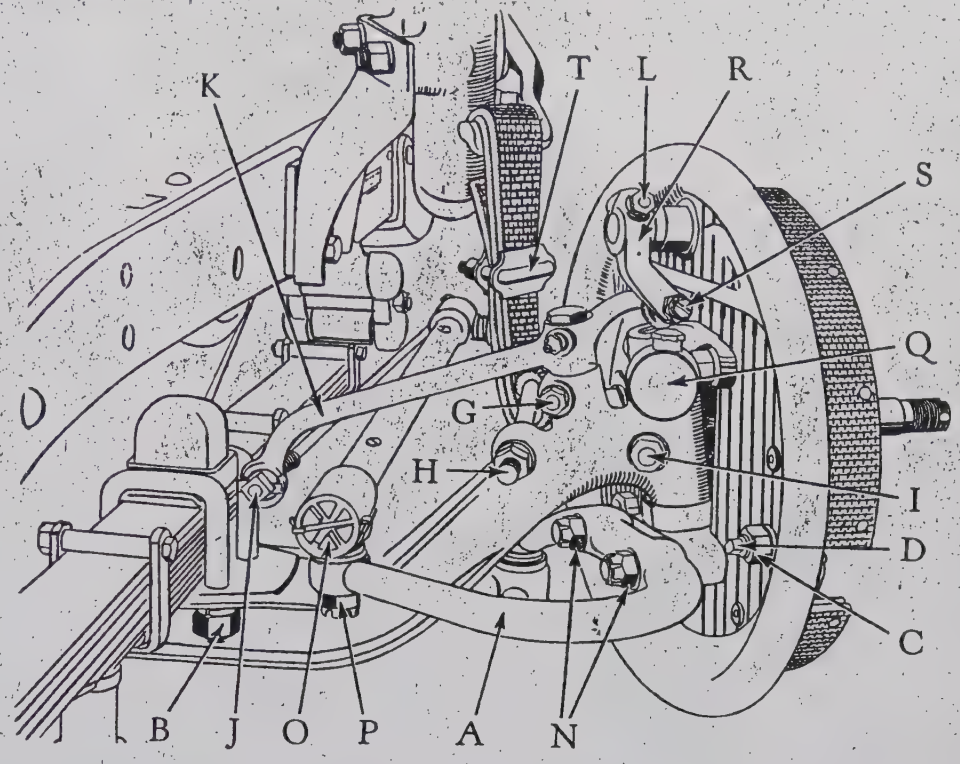
Issued June 1, 1929
Insert in Volume Two, after page 46-D
PRINTED IN U. S. A.



Illus. No. 50
Section Through Steering Knuckle (Dictator)

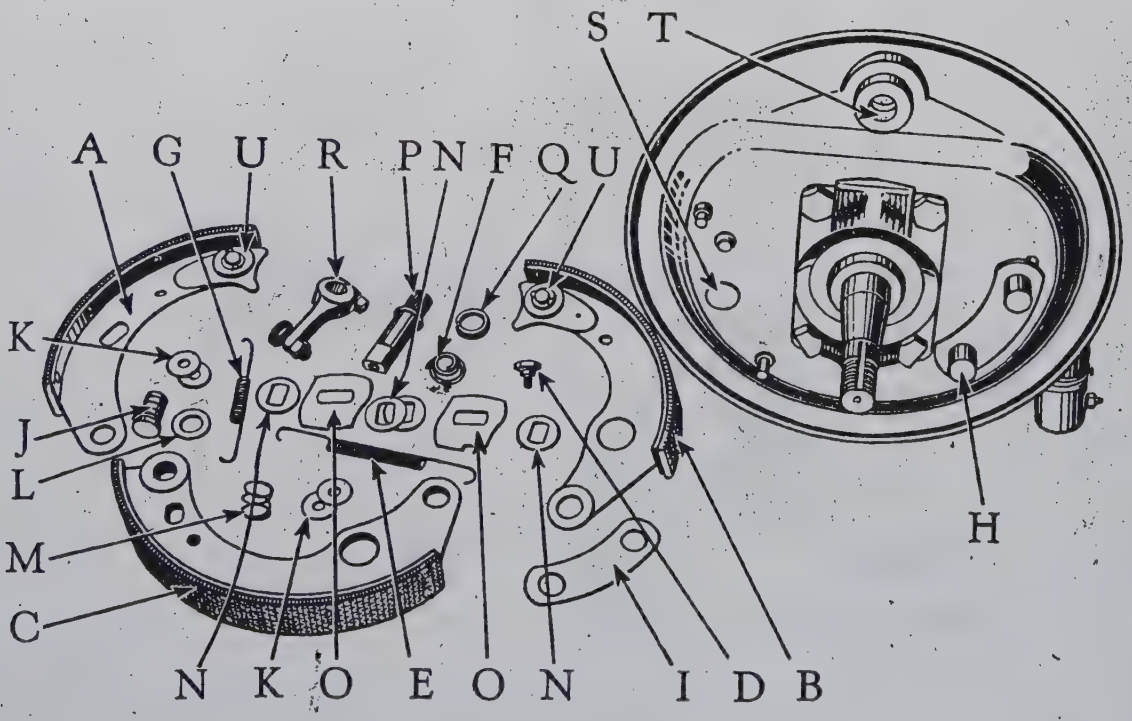


Illus. No. 51
Front Wheel Brake Assembly (Dictator)



Illus. No. 52

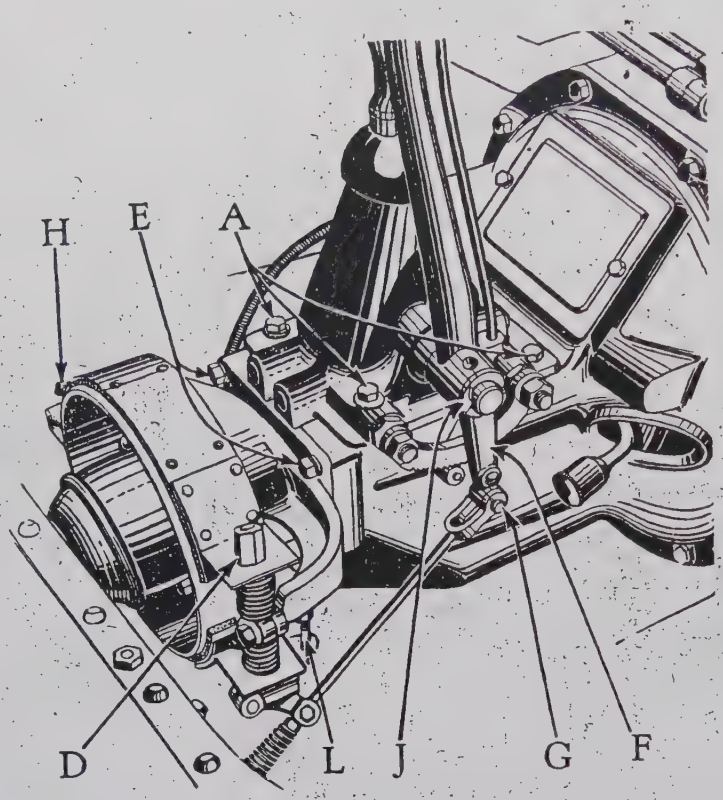
Front View of Left-Hand End of Front Axle (Dictator)



Illus. No. 53

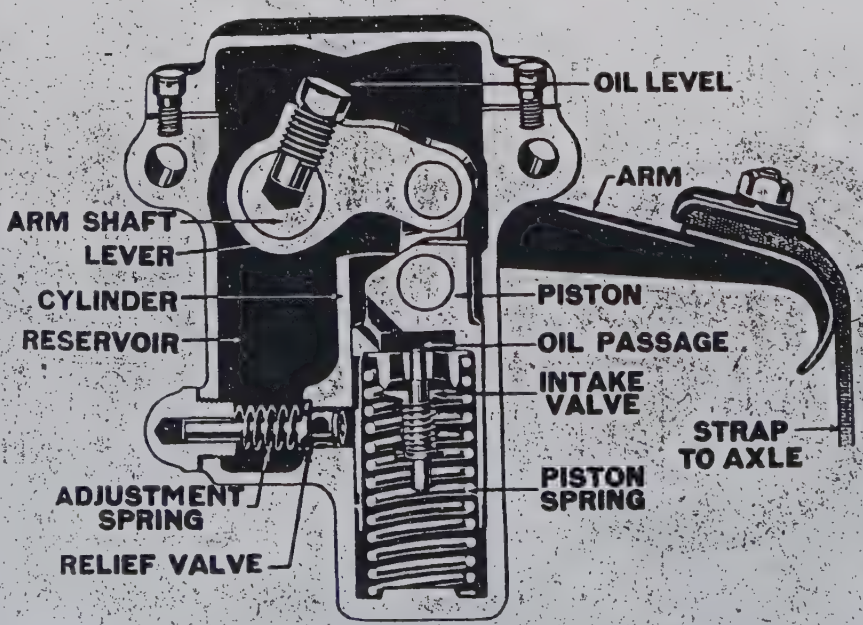
Front Wheel Brake Disassembled (Dictator)

Issued June 1, 1929
Insert in Volume Two, after page 46-F
PRINTED IN U. S. A.



Illus. No. 54

Right Hand Side of Transmission



Illus. No. 55

Sectional View of Lovejoy Shock Absorber

OPERATION ARTICLES

The following section is one containing instructions for disassembling, assembling and repairing various units. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised operation will be carried at the bottom of the green sheets.

For example, the reader is interested in Operation Article No. 3, To Remove and Replace Cylinder Head. Before he reads this, a glance at the bottom of the page will tell whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the Operation Article No. 3, such as 3-1 or 3-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ARTICLE NO. 1

To Remove and Replace Body With Top and Windshield Complete

(Big and Special Six)

1. Remove the hood.

2. Disconnect and remove the radiator brace rods.

3. Unlock and remove the large floor board.

4. Take out the two wood screws holding the small floor board and remove the board.

5. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger locking nut under the toe board and unscrew the plunger from the accelerator rod.

6. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.

7. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.

8. Disconnect the battery ground cable.

9. Remove the junction block housing cover.

10. Disconnect all wires in the large conduit leading to the instrument panel.

11. Loosen the large conduit clamp screws on top of the junction block housing and pull out the conduit and wires.

12. Disconnect the two wires at the relay, if the relay is located on the dash.

13. Turn off the nut holding the oil pressure gauge pipe to the oil pump pipe.

14. If the car has an oil filter disconnect the inlet and outlet pipes at both ends and remove them.

15. Loosen the clamp screws holding the carburetor choke tube and wire to the carburetor.

16. Disconnect the speedometer cable at the speedometer.

17. On hydraulic brake equipment disconnect the service brake pump pressure gauge pipe at "J" (Illus. No. 1).

18. Turn out the wood screw holding the front half of the body lamp wire connector on the right hand sill of the body under the toe board and pull the connector apart.

19. Disconnect the dimmer coil wires at the light switch. On cars equipped with Tilt-Ray headlights this is not necessary.

20. Unscrew the nut holding the windshield wiper pipe at the intake manifold.

21. Disconnect the gasoline gauge pipe at the gauge and pull the pipe out through the hole in the dash.

22. Remove the two nuts on the under side of the instrument panel holding the gasoline gauge. Remove the gauge being careful to hold it upright so that tht liquid will not be spilled.

23. Remove the clevis pin at "H" (Illus. No. 1), disconnecting the parking brake cable.

24. If the car has no steering gear lock, remove the two clamp screws holding the steering gear bracket to the instrument board and omit operations 25 to 28 inclusive.

25. If the car is equipped with a steering gear lock, disconnect the two ignition wires at the lock.

26. Remove the bolts holding the steering gear lock bracket to the instrument board.

27. Loosen the lock bracket clamp screw "D" (Illus. No. 27).

28. With the lock unlocked slide the bracket down on the steering post jacket until the stud is removed from the hole in the instrument board.

29. Remove the seat cushions and slats.

30. Remove the rear fenders. (See Operation Article No. 13).

31. Remove the four body bolt nuts on each side of the body.

32. The body is now free to be lifted from the chassis.

Two lengths of 2x4 placed across under the front and rear of the body can be used as hand holds in lifting the body from the chassis.

33. Reverse operations to replace, making sure that the body shims are correctly placed so that the doors, will open and close properly.

Tools Required—Screw driver, hammer, pliers, No. 23, 27 and 29 open end wrenches, 5/8 inch socket wrench, adjustable wrench.

ARTICLE NO. 2

To Remove and Replace Body With Top and Windshield Complete

(Standard Six)

1. Remove the hood.
2. Disconnect and remove the radiator brace rods.
3. Unlock and remove the large floor board.
4. Take out the two wood screws holding the small floor board and remove the board.
5. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger locking nut under the toe board and unscrew the plunger from the accelerator rod.
6. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.
7. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.
8. Disconnect the battery ground cable.
9. Disconnect the small wire at the right-hand terminal of the starter switch.
10. Remove the wire connected to the front terminal of the relay on Wagner equipment or the top terminal on Remy equipment.
11. Disconnect the primary lead at the top of the coil.
12. Remove the screws in the dash holding the large conduit.
13. Disconnect the oil pressure gauge pipe at the oil pump. If the car is equipped with an oil filter, disconnect the pipe leading from the oil pump to the tee on the dash at both ends and remove the pipe. Disconnect the pipe leading from the filter to the engine crankcase at both ends and remove the pipe.
14. Loosen the clamp screws holding the carburetor choke tube and wire to the carburetor.
15. Disconnect the speedometer cable at the speedometer.
16. Disconnect the dimmer coil wires at the light switch. On cars equipped with Tilt-Ray headlamps this is not necessary.
17. On hydraulic brake equipment disconnect the service brake pump pressure gauge pipe at "J" (Illus. No. 3).
18. Unscrew the nut holding the windshield wiper pipe at the top of the vacuum tank.
19. Unscrew the nut holding the gasoline gauge pipe at the gauge and pull the pipe out through the hole in the dash.
20. Remove the two nuts on the under side of the instrument panel holding the gasoline gauge. Remove the gauge being careful to hold it upright so that the liquid will not be spilled.
21. Remove the clevis pin at "H" (Illus. No. 1), disconnecting the parking brake cable.
22. If the car has no steering gear lock, remove the two clamp screws holding the steering gear bracket to the instrument board and omit operation 23 to 26 inclusive.
23. If the car is equipped with a steering gear lock, disconnect the two ignition wires at the lock.
24. Remove the bolts holding the steering gear lock bracket to the instrument board.
25. Loosen the lock bracket clamp screw "D" (Illus. No. 27).
26. With the steering unlocked slide the bracket down on the steering post jacket until the stud is removed from the hole in the instrument board.
27. Remove the seat cushions and slats.
28. Remove the rear fenders. (See Operation Article No. 13).
29. Remove the four body bolt nuts on each side of the body.
30. The body is now free to be lifted from the chassis.

Two lengths of 2x4 placed across under the front and rear of the body can be used as hand holds in lifting the body from the chassis.

31. Reverse operations to replace, making sure that the body shims are correctly placed so that the doors, will open and close properly.

Tools Required—Screw driver, hammer, pliers, No. 23, 27 and 29 open end wrenches, 5/8 inch socket wrench, adjustable wrench.

ARTICLE NO. 1-1

To Remove and Replace Body with Top and Windshield Complete

(*Big Six*)

The following revision in Article No. 1 applies to Big Six cars having heat and spark control and steering gear lock break-off screws.

1. Remove the hood.
2. Disconnect and remove the radiator brace rods.
3. Unlock and remove the large floor board.
4. Take out the two wood screws holding the small floor board and remove the board.
5. Loosen the accelerator plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.
6. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.
7. Remove the large screw in each side of the toe board and lift out the toe board.
8. Disconnect the battery ground cable.
9. Disconnect the five wires leading from the large conduit on the front of the dash. These wires are attached to the ignition coil, generator, starter switch and two to the lighting switch.
10. Turn off the nut holding the oil pressure gauge pipe to the oil pump pipe at the rear of the engine.
11. Loosen the clamp screws holding the carburetor choke tube and wire to the carburetor.
12. Disconnect the speedometer cable at the speedometer.
13. Drain the water out of the cooling system and disconnect the radimeter connection in the cylinder head.
14. Turn out the wood screw holding the front half of the body lamp wire connector on the right hand sill of the body under the toe board and pull the connector apart.
15. Unscrew the nut holding the windshield wiper pipe to the vacuum tank.
16. Disconnect the gasoline gauge pipe at the gauge and pull the pipe out through the hole in the dash.
17. Remove the two screws on the underside of the instrument panel holding the gasoline gauge. Remove the gauge being careful to hold it upright so that the liquid will not be spilled.
18. Remove the parking brake cable from the connection at "H" (Illus. No. 1) and pull it out through the frame pulleys.
19. Disconnect the manifold heater control wire and tube from the control lever and clamp on the front of the dash.
20. Disconnect the spark advance control wire and tube from the control lever and clamp on the front of the dash.
21. Disconnect the two ignition wires at the steering post lock.
22. With a small cape chisel and hammer, the break off screw which fastens the steering lock bracket to the lock, can be tapped around until loose enough to be turned out with a pair of pliers.
23. Turn out the pinch bolt "D" (Illus. No. 40) which will free the lock body from the bracket.
24. Remove the seat cushions and slats.
25. Remove the rear fenders. (See Operation Article No. 13).
26. Remove the four body bolt nuts on each side of the body.
27. The body is now free to be lifted from the chassis.

Two lengths of 2 x 4 placed across under the front and rear of the body can be used as hand holds in lifting the body from the chassis.

28. Reverse operations to replace, making sure that the body shims are correctly placed so that the doors will open and close properly.

Use a new break-off screw when reconnecting the steering lock. Turn the screw up tight at the time of assembling the parts, but do not break off the small head until the repairs have passed the final inspection.

Tools Required—Screw driver, hammer, pliers, No. 23, 27 and 29 open end wrenches, 5/8 inch socket wrench and an adjustable wrench.

Issued September 15, 1927
Insert in Volume Two, after page 50.
PRINTED IN U. S. A.

ARTICLE NO. 2-1

To Remove and Replace Body with Top and Windshield Complete

(*Standard Six*)

The following revision in Article No. 2 applies to Standard Six cars having heat and spark control and steering gear lock break off screws.

1. Remove the hood.
2. Disconnect and remove the radiator brace rods.
3. Unlock and remove the large floor board.
4. Turn out the two wood screws holding the small floor boards and remove the board.
5. Loosen the accelerator plunger lock nut under the toe board and unscrew the plunger from the accelerator rod.
6. Take out the screws holding the toe plate in the upper left hand corner of the toe board and remove the plate.
7. Remove the large screw in each side of the toe board and lift out the toe board.
8. Disconnect the battery ground cable.
9. Disconnect the wires leading from the large conduit on the front of the dash to the starter switch, generator, ignition coil and lighting switch.
10. Disconnect the oil pressure gauge pipe at the oil pump.
11. Loosen the clamp screws holding the carburetor choke tube and wire to the carburetor.
12. Disconnect the speedometer cable at the speedometer.
13. Drain the water out of the cooling system and disconnect the radimeter connection in the cylinder head.
14. Unscrew the nut holding the windshield wiper pipe to the vacuum tank.
15. Unscrew the nut holding the gasoline gauge pipe at the gauge and pull the pipe out through the hole in the dash.
16. Remove the two screws on the under side of the instrument panel holding the gasoline gauge. Remove the gauge being careful to hold it upright so that the liquid will not be spilled.
17. Remove the parking brake cable from the connection at "H" (Illus. No. 1) and pull it out through the frame pulleys.
18. Disconnect the manifold heater control wire and tube from the control lever and clamp on the front of the dash.
19. Disconnect the spark advance control wire and tube from the control lever and clamp on the front of the dash.
20. Disconnect the two ignition wires at the steering post lock.
21. With a small cape chisel and hammer, the break off screw which fastens the steering lock bracket to the lock, can be tapped around until loose enough to be turned out with a pair of pliers.
22. Turn out the pinch bolt "D" (Illus. No. 40) which will free the lock body from the bracket.
23. Remove the seat cushions and slats.
24. Remove the rear fenders. (See Operation Article No. 13).
25. Remove the four body bolt nuts on each side of the body.
26. The body is now free to be lifted from the chassis.

Two lengths of 2 x 4 placed across under the front and rear of the body can be used as hand holds in lifting the body from the chassis.

27. Reverse operations to replace, making sure that the body shims are correctly placed so that the doors, will open and close properly.

Use a new break-off screw when reconnecting the steering lock. Turn the screw up tight at the time of assembling the parts, but do not break off the small head until the repairs have passed the final inspection.

Tools Required—Screw driver, hammer, pliers, No. 23, 27 and 29 open end wrenches, 5/8 inch socket wrench, adjustable wrench.

ARTICLE NO. 3

To Remove and Replace Duplex Top

1. Remove the toe board. (See Operation Article No. 1, operations 5 to 7 inclusive).
2. Remove the steering post bracket cap or lock. (See Operation Article No. 1, operations 24 to 28 inclusive).
3. Loosen the steering gear case bracket clamp bolt and lower the steering post a few inches.
4. Remove the screws holding the garnish moulding above the instrument board to cowl and remove the moulding.
5. Remove the screws holding the instrument board to the cowl.
6. Lower the instrument board a few inches bracing it carefully so that it will not overturn and spill the liquid from the gasoline gauge.
7. Remove the binding and tacks holding the top decking to the rear body panel and rear quarter top support. Start at "D" (Illus. No. 28) which is about 12 inches up the rear quarter top support and continue down the support, around the back of the rear body panel and up the opposite top support to corresponding point "D" on the other side.
8. Turn the top deck back upon itself.
9. Remove the wood screws holding the rear quarter top support panels to the trim rail at each rear corner of the body.
10. Remove the binding and tacks holding 4th and 5th piping "E" and "F" (Illus. No. 28) on the rear quarter pads and pull the piping loose from the body on each side.
11. Through the openings made in operation 7, remove the nuts and washers from the studs holding the top to the body.
12. Remove the two screws holding each front top support to the cowl.
13. With a man standing on the body sill in each rear door opening shoulders pressing against the top, the top can be raised from the body.
14. Reverse operations to replace.

In reinstalling the top, care must be taken to stretch the decking sufficiently to remove sags, fastening the rear center to the trim rail first, using a pair of pliers to assist in stretching the material back in place. Great care must be used not to tear the material in this operation.

Tools Required—No. 25, 29 and 31 open end wrenches, screw driver, pliers, hammer.

ARTICLE NO. 4

To Remove and Replace Windshield
(Duplex Models)

1. Remove head lining filler "A" (Illus. No. 31) from the front wooden cross member. The filler is fastened to the rear of the front wooden cross member with small finish nails and can be easily detached with a small screw driver.
2. Remove the wing nuts from the windshield adjusting brackets "B" (Illus. No. 31).
3. Remove the screws holding the windshield adjusting brackets to the pillar and remove the brackets.
4. Remove the flat head wood screws from the hinge holding the windshield to the cross member.
5. The windshield can now be removed.
6. Reverse operations to replace.

Tools Required—Screw driver, hammer

ARTICLE NO. 5

To Remove and Replace Top Front Support and Windshield Post
(Duplex Models)

1. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger locking nut under the toe

board and unscrew the plunger from the accelerator rod.

2. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.

3. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.

4. If the car has no steering lock, remove the two cap screws holding the steering column to the instrument board and omit operations 5 to 7 inclusive.

5. Disconnect the two ignition wires at the lock.

6. Loosen the lock bracket clamp screw "D" (Illus. No. 27).

7. With the lock unlocked slide the bracket down on the steering post jacket until the stud is removed from the hole in the instrument board.

8. Loosen the steering gear case bracket clamp bolt and lower the steering post a few inches.

9. Remove the screws holding the garnish moulding (above the instrument board) to the cowl and remove the moulding.

10. Remove the screws holding the instrument board to the cowl.

11. Lower the instrument board bracing it carefully so that it will not overturn and spill the liquid from the gasoline gauge.

12. Remove the three wood screws holding the plate covering the upper top support nut and with a socket wrench remove the nut.

13. Remove cap screws at "A" and "B" (Illus. No. 28) holding the curtain housing rod to the top.

14. Take out the tacks at "C" holding the rear end of the housing upholstering to the top.

15. The front end of the housing rod is engaged over a boss on the front top support and can be removed by pulling toward the rear and moving the rod sideways slightly.

16. If removing the left top support, remove the rubber tubing from the upper and lower ends of the windshield wiper tube which runs through the post.

17. Remove the two bolts holding the top support to the cowl.

18. The top support is now free to be removed.

19. Reverse operations to assemble.

Tools Required—No. 25, 29 and 31 open end wrenches, 9/16 inch socket wrench, screw driver, pliers, hammer.

ARTICLE NO. 6

To Install Windshield Wings on Duplex Models

1. Remove the toe board. (See Operation Article No. 5 operations 1, 2 and 3).

2. Remove the steering post bracket cap. If the car has a steering gear lock, it will be necessary to remove the screws holding the bracket to the instrument board, loosen the clamp screws holding the bracket to the steering post jacket and slide the lock down on the jacket, disengaging it from the instrument board.

3. Loosen the steering gear case bracket clamp bolt and lower the steering post a few inches.

4. Remove the screws holding the garnish moulding (above the instrument board) to the cowl and remove the moulding.

5. Remove the screws holding the instrument board to the cowl.

6. Lower the instrument board a few inches, bracing it carefully so that it will not overturn and spill the liquid from the gasoline gauge.

7. Remove the three screws at the front corner of the top holding the plate covering the windshield post upper fastening nut and remove the plate.

8. Remove the windshield post upper fastening nut holding the post to the top front rail.

9. Remove the rubber tubing from the upper and lower ends of the windshield wiper tube which runs through the post.

10. Remove the two screws holding the windshield post to the cowl and remove the post.

Note—If the car is equipped with the original type post, used previous to serial numbers 2065950 and 3131622 these cannot be used as the metal is too thin to permit drilling and tapping for the side wing lower bracket screws. In that case the windshield posts for the Special Six Sport Roadster should be installed. They will fit any of the other Duplex models and are already drilled and tapped for the side wing bracket screws.

ARTICLE NO. 4-1

To Remove and Replace Windshield

(Closed Bodies)

The following revision in Article No. 4 applies to cars equipped with the Studebaker Ventilating System.

1. Disconnect intake tube to wiper.
2. Remove windshield wiper blade operating handle.
3. Remove the two screws holding the wiper to the windshield frame and remove the wiper.
4. Remove the two cap screws from regulator bracket on windshield.
5. Swing the bottom of the windshield out and support with a wooden brace.
6. Remove the 15 screws from the windshield hinge.
7. Remove windshield.
8. Reverse operations to replace.

Note—Before replacing the windshield see that all the old putty is removed where the windshield hinge fastens onto the body frame. This is necessary if water leaks are to be avoided.

Tools Required—Screw-driver and rubber mallet.

Issued June 1, 1929
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PRINTED IN U. S. A.

11. Remove the stud which held the upper end of the post to the top. In its place put stud 37x112 (Illus. No. 32). On the original top rail construction as shown in Fig. B it will be impossible, when installing the new stud, to use lock nut 22x7 which was on the upper end of the old stud, due to the nut being inaccessible. It should be removed from the top, however, to prevent it from rattling. Replace the nut 21x3 and lock washer as shown in the illustration.

12. Replace the windshield post but do not fully tighten the two screws holding the post to the cowl.

13. Put the bracket which holds the upper end of the side wing in place and put on the acorn nut and lock washer. Then put in the wood screws holding the other end of the bracket.

14. The screws fastening the lower end of the post may now be tightened.

15. Insert the side wing upper hinge in the bracket. Bring the lower end into position according to the dimensions given in the illustration and locate the two screw holes on the post.

16. Use a No. 17 drill for these holes and then tap for a No. 12-24 thread.

If it was found necessary to use new windshield posts for the reason described under operation No. 10, the operations of drilling and tapping will not be necessary. The new windshield posts will already have these holes.

17. Put the lower side wing hinge in place and put in the two fastening screws.

18. Put the rubber tubing over the upper and lower ends of the windshield wiper tube running through the left post.

19. Complete assembly by reversing operations 1 to 7 inclusive.

Tools Required—Screw driver, No. 23, 25, 29 and 31 open end wrenches, pliers, 9/16 inch socket wrench, hammer, No. 17 drill, ¼-24 tap.

ARTICLE NO. 7

To Remove and Replace Instrument Panel

1. Unscrew the connection holding the speedometer cable to the speedometer.

2. Unscrew the nut holding the gasoline gauge air pipe to the gasoline gauge.

3. Unscrew the nut holding the engine oil pressure pipe to the oil gauge.

4. On hydraulic brake equipment, unscrew the nut holding the service brake pump oil pressure pipe to the gauge.

5. Remove the nuts and washers holding the wires to the ammeter and remove the wires

6. Remove the four nuts and washers holding the panel to the instrument board.

7. The instrument panel can now be removed.

When removing the panel be very careful to hold it upright so that the liquid in the gasoline gauge will not be spilled.

8. Reverse operations to replace.

Tools Required—No. 25 open end wrench, pliers.

ARTICLE NO. 8

To Remove and Replace Berline Partition

1. Remove brads "D" (Illus. No. 30).

2. Open the partition trim rails "C" exposing the three corner iron screws "B" on each side.

3. Remove the six corner iron screws.

4. The partition can now be removed.

5. Take the partition out through the front door.

6. Reverse operations to assemble.

Tools Required—Screw driver, hammer, pliers.

ARTICLE NO. 9

To Install Berline Partition in Sedan Body

1. Take partition "A" (Illus. No. 30) into the body through the front door, placing it on the back of the front seat, with the edge of the partition flush with the seat as shown at "E".
2. Open partition trim rails "C" exposing recesses for corner irons.
3. Place corner irons "B" in the recesses, one at a time, with the long side of the iron against the body pillar and mark the positions of the screw holes on the partition.
4. Drill a 5/32 inch hole at each point marked.
5. Fasten the corner irons to the partition, using No. 12—1¼ inch flat head wood screws.
6. Locate the ends of the partition so they are equally spaced on the body pillars.
7. Drill the holes and fasten the two bottom corner irons to the body pillar.
8. Bring the top of the partition to a perpendicular position and fasten the two top corner irons.
9. Fasten the two center corner irons.
10. Close the trim rails and fasten each one with No. 16—1½ inch brads. Sink the brads with a nail punch.

Tools Required—Hand drill, 5/32 inch drill, screw driver, hammer, nail punch.

ARTICLE NO. 10

To Remove Seat Backs on Closed Cars

1. Remove the seat cushion.
2. Loosen the three lock nuts at the bottom of the seat back and screw them up about half way on the stud.
3. Screw the three lower nuts up on the stud far enough to allow the seat back to drop down about an inch.
4. The seat back can now be removed.
5. Reverse operations to replace.

Tools Required—Two No. 27 open end wrenches.

ARTICLE NO. 11

To Remove and Replace Duplex Curtains

1. Remove the cap screws at "A" and "B" (Illus. No. 28) holding the curtain housing rods to the top.
2. Take out the tacks at "C" holding the rear end of the housing upholstering to the top.
3. The front end of the housing rod is engaged over a boss on the front top support panel and can be removed by pulling gently toward the rear and moving the rod sideways slightly.
4. Raise the housing and rod and pin it to the inside of top. This exposes the curtains hung in brackets similar to the ordinary window shade.
5. Remove the curtain by lifting one end out of the slotted bracket and then removing the other end from the other bracket.

When removing the curtains from the brackets, the spring in the roller will uncoil.

6. If necessary to remove the curtain material from the roller, spread apart one end of the metal groove in the roller and pull out the material.
7. To replace the front curtain, first give the roller spring twenty-five complete turns and see that pawl "B" (Illus. No. 29) on the end of the roller engages the cam, holding the spring wound up.

Unroll the curtain and mount it in the brackets. It is advisable to replace the front curtains unrolled, because of the small clearance at the front of the top.

Note—Be sure to mount the curtain with pawl "B" (Illus. No. 29) down.

Raise the curtain and then draw it down again

ARTICLE NO. 10-1

To Remove and Replace Front Seat Backs on Closed Cars

The following revision in Article No. 10 *applies to cars equipped with custom bodies.*

1. Remove the seat cushion.
2. Remove the tacks holding the bottom of the seat back in place.
3. Loosen the wire on binding and take out the tacks holding the top of the seat back in place.
4. Remove the small nails, which holds the spring clips in place at the top of the seat back spring.
5. The seat back can now be removed.
6. Reverse operations to replace.

Tools Required—Trimmer's hammer and screw driver.

ARTICLE NO. 10-2

To Remove and Replace Rear Seat Backs on Closed Cars

The following revision in Article No. 10 *applies to cars equipped with custom bodies.*

1. Remove the seat cushion.
2. Remove the two screws that hold the bottom of the seat back in place.
3. Raise the seat back up, it will come loose at the top and can then be removed.
4. Reverse operations to replace.

Tools Required—Screw-driver.

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PRINTED IN U. S. A.

with the front edge in the groove in the front top support panel, fastening the curtain over the stud on the outside of the body.

To replace the rear curtain give the roller spring twenty complete turns and see that the pawl on the end of the roller engages the cam, holding the spring wound up.

Mount the curtain, rolled up, in the brackets, with the pawl down as on the front curtain.

Draw the curtain down with the rear edge in the groove in the rear quarter top support panel and fasten the curtain over the stud on the outside of the body.

Reverse operations 1 to 4 to complete the assembly.

Tools Required—No. 25 open end wrench, pliers, hammer.

ARTICLE NO. 12

To Remove and Replace Front Fender

1. Remove the head lamp.
2. Unscrew the nuts and remove the four bolts at the head lamp bracket.
3. Remove the four fender to frame bolts.
4. Remove the seven fender to splasher bolts.
5. Unscrew the three nuts holding the fender to the running board.
6. Unscrew the nuts and remove the four fender bracket to frame bolts.
7. The fender can now be removed.
8. Reverse operations to assemble.

Tools Required—Screw driver, pliers, hammer, No. 23 and 27 open end wrenches.

ARTICLE NO. 13

To Remove and Replace Rear Fender

1. Remove the nuts on the bolts holding the fender to the running board.
2. Remove the nuts and remove the fender to splash guard bolts.
3. Remove the nuts and take out the bolts at the rear of the fender.
4. Take out the bolts holding the fender to the body.
5. The fender is now free to be removed.
6. Reverse operations to assemble.

Tools Required—Screw driver, pliers, hammer, No. 23 and 25 open end wrenches.

ARTICLE NO. 14

To Remove and Replace Running Board

1. Unscrew the three nuts holding the front fender to the running board.
2. Unscrew the three nuts holding the rear fender to the running board.
3. Remove the wood screws holding the splasher to the inner edge of the running board.
4. Remove the six nuts on the bolts holding the running board to the running board brackets.
5. The running board is now free to be removed.
6. Reverse operations to replace.

Tools Required—No. 25 open end wrench, screw driver, pliers and hammer.

ARTICLE NO. 15

To Remove and Replace Splash Guard

1. Remove the five screws holding the hood sill to the frame and remove the sill.
2. Remove the front fender. (See Operation Article No. 12).
3. Remove the rear fender. (See Operation Article No. 13).

4. Remove the running board. (See Operation Article No. 14).
5. Turn off the nuts on the four body bolts on the side from which the splash guard is to be removed, and remove the front bolt only.
6. Disconnect the oil pressure gauge pipe from the oil pump.
7. Raise the side of the body slightly to clear the splash guard and frame.
8. Unscrew the nuts on the four stove bolts holding the splash guard to the top of the frame and remove the bolts.
9. The splash guard is now free to be removed.
10. Reverse operations to replace, making sure that the anti-squeak strip is in place between the splash guard and the frame.

Tools Required—No. 25 and No. 29 open end wrenches, screw driver, pliers, ½ and ⅝ inch socket wrenches, pry bar and hammer.

ARTICLE NO. 16

To Adjust Gabriel Snubbers

1. With the snubber adjusting wrench (C.O. 261) pull the belt out of the cup as far as possible or until the coil spring, within the snubber, is entirely compressed (Illus. No. 34).
2. Let it return into the cup two inches and place a wedge between the belt and the cup at the top of the cup opening to hold the tension or adjustment on the coil. This will leave the belt slack between the snubber and the axle.
3. Remove the belt clamp at the axle and cut off the belt to the proper length so as to take out the slack and make it taut.
4. Replace the clamp. The belt should now have no slack.
5. Remove the wedge.

Tools Required—Snubber adjusting wrench C. O. 261, wooden wedge, pliers, No. 25 open end wrench.

ARTICLE NO. 17

To Remove and Replace Motometer

1. Unscrew the radiator cap.
2. With a ⅛ inch drill, drill out the lead plug at "A" (Illus. No. 35). Clean out the remainder of the lead plug from the hexagon opening in the set screw "A".
3. Remove set screw "A".
4. Unscrew the knurled sleeve "B". Tie the chain in such a manner as to prevent it slipping into the radiator.
5. Remove the nut and lock washer "C".
6. Remove the motometer from the radiator cap.
7. Reverse operations to assemble. Be sure to put a lead plug in the set screw after tightening.

Tools Required—Hand drill, ⅛ inch drill, offset hexagon wrench for set screw "A", 1 inch socket wrench.

ARTICLE NO. 18

To Remove and Replace Clock

1. Drill two 7/64 inch holes 7/32 of an inch apart, in the head of each clock fastening screw (Illus. No. 36).
2. Insert special wrench C.O. 157 in these holes and remove the screws.

Warning—Do not attempt to remove these screws with a punch or chisel. Such procedure will invariably break the clock.

3. The fastening clip and the clock can now be removed.

ARTICLE NO. 12-1

To Remove and Replace Front Fender

The following revision in Article No. 12 *applies to cars with full crown fenders.*

1. Remove the three nuts and remove the bolts at the head lamp bracket.
2. Remove the five fender to frame bolts.
3. Remove the eight fender to splash guard bolts.
4. Remove the three fender to frame screws.
5. Unscrew the three nuts holding the fender to the running board.
6. Unscrew the two nuts holding the fender to the fender cross reinforcement.
7. The fender can now be removed.
8. Reverse operations to replace.

Tools Required—No. 25 and 27 open end wrench, ½ inch socket wrench, screw-driver, hammer and pliers.

ARTICLE NO. 15-1

To Remove and Replace Splash Guard

The following revision in Article No. 15 *applies to cars with full crown fenders.*

1. Remove the rear fender.
2. Remove running board.
3. Remove the body bolts.
4. Remove the front fender to splash guard bolts.
5. Raise the side of the body from the frame.
6. Remove the splash guard to frame bolts.
7. The splash guard can now be removed.
8. Reverse operations to replace.

Tools Required—No. 25 and 29 open end wrenches, hammer, pry bar, ⅝ inch socket wrench, screw-driver and pliers.

ARTICLE NO. 16-1

To Remove, Replace and Adjust Monroe Shock Eliminators

1. Loosen and remove the strap clamp from the axle.
2. Remove the nuts from the mounting studs holding the eliminator to the frame and remove from the car.
3. Reverse operations to replace.
4. In replacing the eliminators adjust the arm and strap as follows: The strap should be attached so that, with the car normally loaded, the end of the arm is about one inch below the line of the mounting studs. If installing a new strap allow approximately two inches below the line of the mounting studs to allow for stretching after car has been driven a short time.

Always make sure the strap clamps are tight and the strap ends are accurately aligned.

Tools Required—No. 27 and 29 open end wrenches, and pliers.

Issued June 1, 1929
Insert in Volume Two, after page 56
PRINTED IN U. S. A.

ARTICLE NO. 16-2

To Disassemble and Assemble Monroe Shock Eliminators

1. Remove the eliminator (See Operation Article 29).

2. Remove the filler plug "M" Illus. No. 13 President Eight Section and drain out all the oil possible through the filler plug hole.

3. Clamp the eliminator in vise (using the flat part of case). Loosen the cover screws "N" and hold the arm "B" down with the hand and then remove the screws.

4. Lift off the cover "E" and cover gasket "F".

5. Allow the arm to come up slowly, at the same time holding the piston "G" so that it will not fly out of the case when the cam lever "B" moves off the piston.

6. By working the arm to a certain position, it and the cam lever together with the gaskets "D" and "C" will come out of the case. Do not hammer the arm when disassembling as the bearings may become damaged.

7. Remove the piston "G" spring "H" and intake valve "I".

8. Remove the acorn nut "J" and take out the valve "L".

9. Reverse operations to replace.

Note—With a "C" clamp force the arm and packing into place, first making sure that the latter is started into its recesses. Screw up the "C" clamp until the thrust bearing will pass the one in the case. Push down piston, following it up with the arm and cam lever. Remove the "C" clamp.

Tools Required—Adjustable wrench, screwdriver, pliers and "C" clamp.

4. To replace, two new fastening screws, Part No. 106461, are required. Replace the clock and fastening clip. Then turn in the fastening screws with a screw driver until the heads break off (Illus. No. 36).

Tools Required—Screw driver, wrench C. O. 157, hand drill, 7/64 inch twist drill.

ARTICLE NO. 19

To Install Heater on Closed Car

(Big and Special Six)

1. Remove the front floor board.

2. Fasten the valve operating handle sub-frame to the body sill and the front seat cross member with wood screws. When correctly fastened the bottom of the sub-frame should be ¾ of an inch above the top of the chassis frame and the center line of the handle 4½ inches from the front seat heel board. (See Illus. No. 33). This should bring the slot for the handle 15 inches from the car center line.

3. Bolt the valve handle proper securely to the under side of the sub-frame at the holes which are punched in the sub-frame. The lever and T-handle will extend up through the hole in the sub-frame.

4. To locate for the cut-out in the front floor board for the T operating handle, measure the distance from the body sill to the lever of the handle. This will give the center of the cut-out crosswise of the car. The sides of the hole will then be 19/32 of an inch on each side of this point. Mark the lines on the board with a pencil. The center of the hole lengthwise will be 4½ inches measured from the edge of the floor board which fits against the front seat cross member. The hole will be 1⅝ of an inch on each side of this.

5. Cut the hole in the board by drilling a ¾ of an inch hole in each one of the four corners and cutting out between, along the lines with a key-hole saw. Be sure to cut back on the drill to obtain square corners, otherwise the stamped cover plate will not go in place.

6. The cover plate can now be screwed into position.

7. With the floor board in place and the carpet in place, cut out the carpet by running a knife around the outside of the stamped cover plate. This hole in the carpet must be bound with leather or heavy wool binding.

8. Clamp the heater valve to the exhaust pipe 14 3/16 inches from the front end of the muffler.

9. Connect up the control rod "F" (Illus. No. 33) to determine whether or not the control mechanism is in the proper position for the valve. If rod "F" does not fall in the correct position with the lever gear "C" so that the valve will operate, move the valve forward or back on the exhaust pipe until the correct relation between gear "C" and rod "F" is established.

10. Scribe along the front and rear of the valve on the exhaust pipe.

11. Remove the valve from the pipe.

12. Measure ⅜ of an inch in from each scribe mark and scribe again to obtain the length of the hole to be cut in the pipe.

13. With a hacksaw, cut in from the scribe marks at a 45° angle to approximately ¾ of an inch. Do not cut at right angle to the pipe, or the valve will not function properly.

14. Cut parallel to the pipe between the end of the saw cuts. This can be done with a cutting torch or by drilling and chipping between the drill holes. Extreme care must be taken not to bend or distort the exhaust pipe at this point.

15. Clamp the valve in position and open and close it to test for interference. If these are found it will be necessary to file the exhaust pipe until the correct operation is obtained. Then clamp the valve securely to the pipe.

16. The heater proper is set in a hole in the rear floor board and is screwed directly to the floor board. To locate this hole, measure from the front of the back seat and scribe a line. See the following measurements to be used on the different body models:

Big Six Sedan and 5-pass. Coupe	9¾ inches
Special Six Brougham	9¾ inches
Big Six Brougham	14½ inches
Special Six Sedan	14½ inches

Special Six Victoria 2¾ inches

17. Measure 5⅜ inches from the line scribed, for the forward line of the hole. The ends of the cut-out will be 12 5/16 inches on either side of the center line of the floor board for Big and Special Six Sedans and 8 11/16 inches on all other body models.

18. Cut out the floor board along the lines thus determined by drilling ¾ inch holes at the four corners and cutting beween the holes with a key-hole saw.

19. The heater can now be screwed into position.

20. See operation No. 7 to cut the hole in the carpet.

21. Connect an end of the flexible tube "G" (Illus. No. 33) to the heater valve and connect the other end to the boss on the left side of the heater.

22. Connect the exhaust pipe "M" into the boss on the right side of the heater and run it back over the rear axle housing as shown in Illus. No. 33.

23. Fasten the support "N" to the rear floor boards with two bolts in counterbored holes in the board.

24. Fasten support "O" to the rear seat board at a location suitable. This can be determined by putting the support in position and locating the drill for the bolts from the hole in the support.

25. Fasten the two front supports "H" and "J" as shown in Illus. No. 33. "H" is bolted to the body in line with the front end of the muffler. "J" is bolted to the rear floor board approximately 1½ inches in front of the frame cross member.

Tools Required—Pliers, hammer, chisel, screw driver, adjustable wrench, No. 23 and 27 open end wrenches, 1 foot scale, file, hand drill, 1/8, 1/4, /5-16, 3/8 and 3/4 inch drills, hacksaw, key-hole saw.

ARTICLE NO. 20

To Install Heater on Closed Car

(Standard Six)

1. Remove the front floor board.

2. Fasten the valve operating handle sub-frame to the body sill and the front seat cross member with wood screws. When correctly fastened the bottom of the sub-frame should be ¼ of an inch above the top of the chassis frame and the center line of the handle 4¼ inches from the front seat heel board. (See Illus. No. 33). This should bring the slot for the handle 10½ inches from the car center line.

3. Bolt the valve handle proper securely to the under side of the sub-frame at the holes which are punched in the sub-frame. The lever and T-handle will extend up through the hole in the sub-frame.

4. To locate for the cut-out in the front floor board for the T operating handle, measure the distance from the body sill to the lever of the handle. This will give the center of the cut-out crosswise of the car. The sides of the hole will then be 19/32 of an inch on each side of this point. Mark the lines on the board with a pencil. The center of the hole lengthwise will be 4½ inches measured from the edge of the floor board which fits against the front seat cross member. The hole will be 1⅝ inches on each side of this.

5. Cut the hole in the board by drilling a ¾ inch hole in each one of the four corners and cutting out between, along the lines with a key-hole saw. Be sure to cut back on the drill to obtain square corners, otherwise the stamped cover plate will not go in place.

6. The cover plate can now be screwed into position.

7. With the floor board in place and the carpet in place, cut out the carpet by cutting around the outside of the stamped cover plate. This hole in the carpet must be bound with leather or heavy wool binding.

8. Clamp the heater valve to the exhaust pipe 14 3/16 inches from the front end of the muffler.

9. Connect up the control rod "F" (Illus. No 33) to determine whether or not the control mechanism is in the proper position for the valve. If rod "F" does not fall in the correct position with the lever gear "C" so that the valve will operate, move the valve forward or back on the exhaust pipe until the correct relation between gear "C" and rod "F" is established.

10. Scribe along the front and rear of the valve on the exhaust pipe.

11. Remove the valve from the pipe.

12. Measure 3/8 of an inch from each scribe mark and scribe again to obtain the length of the hole to be cut in the pipe.

13. With a hacksaw, cut in from the scribe marks at a 45° angle to approximately 5/8 of an inch. Do not cut at right angle to the pipe, or the valve will not function properly.

14. Cut parallel to the pipe between the end of the saw cuts. This can be done with a cutting torch or by drilling and chipping between the drill holes. Extreme care must be taken not to bend or distort the exhaust pipe at this point.

15. Clamp the valve in position and open and close it to test for interferences. If these are found it will be necessary to file the exhaust pipe until the correct operation is obtained. Then clamp the valve securely to the pipe.

16. The heater proper is set in a hole in the rear floor board and is screwed directly to the floor board. To locate this hole, measure 9¾ inches from the front of the back seat and scribe a line.

17. Measure 5⅜ inches from the line scribed for the forward line of the hole. The ends of the cut-out will be 8 11/16 inches on either side of the center line of the floor board.

18. Cut out the floor board along the lines thus determined by drilling ¾ inch holes at the four corners and cutting between the holes with a key-hole saw.

19. The heater can now be screwed into position.

20. See Operation No. 7 to cut the hole in the carpet.

21. Connect an end of the flexible tube "C" (Illus. No. 33) to the heater valve and connect the other end to the boss on the left side of the heater.

22. Connect the exhaust pipe "M" into the boss on the right side of the heater and run it back over the rear axle housing as shown in Illus. No. 33.

23. Fasten the support "N" to the rear floor boards with two bolts in counterbored holes in the board.

24. Fasten support "O" to the rear seat board at a location suitable. This can be determined by putting the support in position and locating the drill for the bolts from the hole in the support.

25. Fasten the two front supports "H" and "J" as shown in Illus. No. 33. "H" is bolted to the body in line with the front end of the muffler. "J" is bolted to the rear floor board approximately 1½ inches in front of the frame cross member.

Tools Required—Pliers, hammer, chisel, screw driver, adjustable wrench, No. 23 and 27 open end wrenches, 1 foot scale, file, hand drill, 1/8, 1/4, 5/16, 3/8 and 3/4 inch drills, hacksaw, key-hole saw.

ARTICLE NO. 21

To Remove and Replace Front Wheel Brake Shoes

1. Remove the front wheel. (See Operation Article No. 1, Vol. 1, or use the following operations):

   A. Place a jack under the axle, raising until the wheel to be removed is free from the floor.

   B. Remove the hub cap.

   C. Remove the cotter pin in the steering knuckle spindle (Illus. No. 4).

   D. Unscrew the bearing adjusting nut (Illus. No. 4).

   E. Remove the bearing lock washer.

   F. The wheel and bearings can now be pulled off of the steering knuckle.

2. Remove the cotter pins and flat washers from pins "C" (Illus. No. 13).

3. Remove spacer bolts "L" and "M" (Illus. No. 13) together with spacers, springs and washers.

4. Remove screw and washer "J".

5. Remove both brake shoes at once leaving spring "K" fastened to the shoes.

6. After the shoes are removed, unfasten spring "K".

7. Reverse operations to assemble.

Note—Be sure to mount the brake shoes on the same pin "C" (Illus. No. 15) from which they were removed.

If for any reason this is not done, or if new

brake lining has been put on the shoes proceed as follows after all parts, including the front wheel have been assembled:

Remove clevis pin at "M" (Illus. No. 11).

Loosen two screws "C" (Illus. No. 11).

Pull lever "M" back as far as possible thus expanding the brake shoes tightly against the drums. This will locate support "B" in the proper position. Try to insert a .020 inch feeler gauge between the drum to determine if the shoes are seating properly. Apply the feeler at the center of each shoe. The clearance should be too small for it to enter.

With the lever "M" held in this position, tighten screws "C".

The above operations will compensate for any small inequalities in the brake shoes or in the thickness of the lining and will equalize the movement of the shoes.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25 and 29 open end wrenches, feeler gauge.

ARTICLE NO. 22

To Remove and Replace Front Wheel Brake Cam Support

1. Remove the front wheel brake shoes. (See Operation Article No. 21).
2. Remove screw "E" (Illus. No. 11) and drive off lever "F" leaving it fastened to connecting link "G" as shown in Illus. No. 15.
3. Remove the Woodruff key from cam "I" (Illus. No. 15) and remove the cam.
4. Remove nut "D" (Illus. No. 15).
5. Remove bolts "H". Dust shield "N" can now be removed.
6. Remove screws "C" (Illus. No. 11). Support "N" can now be removed.
7. Reverse operations to assemble. Note operation 7 in Operation Article No. 21 being careful to locate the support in the manner described.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25 and 29 open end wrenches, feeler gauge.

ARTICLE NO. 23

To Remove and Replace Front Wheel Brake Connecting Link

1. Turn the front wheel in the extreme position as shown in Illus. No. 11.
2. Remove the cotter pin and unscrew plug "A" (Illus. No. 2) from the upper end of the link.
3. Remove the end of the link from the ball bolt and remove parts "B", "C" and "D" (Illus. No. 2).
4. Repeat operations 2 and 3 at the lower end of the link.
5. Reverse operations to assemble. In replacing plugs "A" turn them in until flush with the end of the sockets.

Then check the position of the front brake long lever. (Illus. No. 14). This lever should be pointing down at an angle of 45° to 50° in front of vertical.

If this is not the case a slight adjustment can be made by screwing plugs "A" (Illus. No. 2) in opposite directions a short distance, as required.

Be sure to install cotter pins after making the adjustment.

Tools Required—Pliers, screw driver.

ARTICLE NO. 24

To Remove and Replace Front and Rear Disc Wheel Brake Drum
(Big and Special Six)

1. Place a jack under the axle, raising until the wheel to be removed is clear of the floor.
2. Remove the six nuts holding the wheel to the hub and remove the wheel. The nuts on the

ARTICLE NO. 21-1

To Remove and Replace Front and Rear Brake Shoes

The following revision in Article No. 21 applies to Commander cars equipped with Bendix brakes.

1. Remove the front wheel, or use the following operations:
   - A. Place a jack under the axle, and raise until the wheel to be removed is free from the floor.
   - B. Remove the hub cap.
   - C. Remove cotter pin and bearing adjusting nut.
   - D. Remove the bearing retainer washer.
   - E. The wheel and bearings can now be pulled off the steering knuckle spindle.

Note—To remove the rear wheel use wheel puller. See Vol. 8 or tool catalogue for proper puller.

2. Remove the nut "H" (Illus. No. 43) and washer from the secondary shoe anchor-pin.

3. Lift off the anchor-pin reinforcing strap "I" from the anchor-pins, and plain washer from the auxiliary shoe anchor-pin.

4. Remove the cotter pin and lift both washers and spring off of the steady rest pin "K" through primary shoe "A".

5. Loosen lock nut "C" (Illus. No. 45) and rotate the eccentric adjustment "D" away from the articulating pin as far as possible.

6. Remove springs "E" and "G" (Illus. No. 43).

7. The shoes can now be removed.

8. After the shoes have been removed the articulating pin "H" (Illus. No. 47) can be taken out which will separate the shoes.

9. Reverse operations to assemble.

Note—Primary shoe "A" and auxiliary shoe "B" (Illus. No. 43) are exactly alike in shape. If the same shoes are to be replaced, care must be taken to see that they are replaced, in their former position.

The brake cam "D" must always have the arrow pointing away from the spindle so that the long side of the cam (arrow) is next to the primary shoe when the brake is applied.

After wheels have been replaced, adjust the brakes as instructed in Operation Article No. 40-2.

Tools Required—Jack, hub cap wrench, No. 25 and 27 open end wrenches, hammer, screw-driver and pliers.

ARTICLE NO. 21-2

To Remove and Replace Front and Rear Brake Shoes

The following revision in Article No. 21 applies to Dictator cars equipped with Bendix Brakes.

1. Remove the front wheel. See Operation Article No. 1, Vol. 1, Page 137 or use the following operations:
   - A. Place a jack under the axle, and raise until the wheel to be removed is free from the floor.
   - B. Remove the hub cap.
   - C. Remove the cotter pin and bearing adjusting nut.
   - D. Remove the bearing retainer washer.
   - E. The wheel and bearings can now be pulled off the steering knuckle spindle.

Note—To remove the rear wheel use wheel puller. See Vol. 8 or tool catalogue for proper puller.

2. Remove the cotter pins from anchors "H" (Illus. No. 51) and remove the plate "I".

3. Remove the cotter pins and washers from the steady rest pins "K".

4. Loosen lock nut "C" (Illus. No. 52) and rotate the eccentric adjustment "D"away from the articulating pin as far as possible.

5. Remove the springs "G" and "E" (Illus. No. 51).

6. The shoes can now be removed.

7. After the shoes have been removed the articulating pin "J" can be taken out which will separate the shoes "A" and "C".

8. Reverse operations to replace.

9. See Operation Article No. 40-3 to adjust the brakes.

Tools Required—Jack, hub cap wrench, hammer, screw-driver and pliers.

Issued June 1, 1929
Insert in Volume Two, after page 60.
PRINTED IN U. S. A.

ARTICLE NO. 22-1

To Remove and Replace the Brake Cam

The following revision in Article No. 22 applies to Dictator cars equipped with Bendix 4-Wheel Brakes.

1. Remove the brake shoes (See Operation Article 21-1A).
2. Loosen clamp bolt "L" (Illus. No. 52) and remove cam lever "R".
3. Remove the cap screw "D" (Illus. No. 51). The washers "N" cam "O" and springs "Q" can be removed.
4. The camshaft "P" can now be removed.
5. The bushing "T" in the cam support if worn can now be replaced.
6. Reverse operations to replace.

Note—When assembling the cam make sure that the long side "D" (Illus. No. 51) is next to the primary shoe "A" when the brakes are applied.

Tools Required—No. 25 and 27 open end wrench, hammer, screw-driver and pliers.

ARTICLE NO. 22-2

To Remove, Disassemble and Replace Perrot Control

The following revision in Article No. 22 applies to Commander cars equipped with the Bendix Perrot Control.

1. Remove the brake shoes (See Operation Article No. 21-1).
2. Remove rod adjusting nut "J" (Illus. No. 45) and loosen clamp bolt "L".
3. Pull out cotter pins and remove nuts "M", lock washers and bolts.
4. Control shaft assembly "R" can now be removed.
5. Remove key "K" (Illus. No. 46) from bracket "L".
6. To disassemble control shaft remove locking ring "F" (Illus. No. 46) spring retainer "G" spring "H" and dust retainers "I" and "J".
7. Remove key "K" from bracket "L" and the bracket can be removed.
8. Cam "M" can be removed from "A".
9. Take out pin "O" and "P" can be forced out, releasing cam "A" from shaft "N".
10. Reverse operations to assemble and replace.

Tools Required—No. 23 and 25 open end wrenches, hammer, screw-driver, pliers and punch.

left-hand side have a left-hand thread and on the right-hand side a right-hand thread.

3. If removing the front wheel drum, remove the front wheel hub. (See Operation Article No. 1, Vol. 1, or use the following operations):

A. Remove the hub cap.
B. Remove the cotter pin in the steering knuckle spindle (Illus. No. 4).
C. Unscrew the bearing adjusting nut (Illus. No. 4).
D. Remove the bearing lock washer.
E. The wheel hub and bearings can now be pulled off the steering knuckle.

4. If removing the rear wheel drum, remove the rear wheel hub. (See Operation Article No. 42, Vol. 1, or use the following operations):

A. Unscrew the hub cap.
B. Pull the cotter pin and unscrew the axle shaft nut ((Illus. No. 16).
C. Screw on the wheel puller and pull the wheel (Illus. No. 17).

5. With a chisel and hammer cut the six rivets holding the brake drum to the wheel hub and drive out the rivets.

6. The drum can now be removed.

7. Reverse operations to replace.

Bolt the drum in place on the hub using two bolts opposite each other in the rivet holes. This will hold the drum in place while the rivets are being installed. Heat the rivets, do not attempt to install them cold.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 25 and 29 open end wrenches, axle shaft nut wrench, wheel puller, chisel and hammer.

ARTICLE NO. 25

To Remove and Replace Front and Rear Disc Wheel Brake Drum

(Standard Six)

1. Place a jack under the axle, raising until the wheel to be removed is clear of the floor.

2. If removing the front wheel drum, remove the front wheel. (See Operation Article No. 1, Vol. 1, or use the following operations):

A. Remove the hub cap.
B. Remove the cotter pin in the steering knuckle (Illus. No. 4).
C. Unscrew the bearing adjusting nut (Illus. No. 4).
D. Remove the bearing lock washer.
E. The wheel hub and bearings can now be pulled off the steering knuckle.

3. If removing the rear wheel drum, remove the rear wheel. (See Operation Article No. 39, Vol. 1, or use the following operations):

A. Unscrew the hub cap.
B. Pull the cotter pin and unscrew the axle shaft nut (Illus. No. 16).
C. Screw on the wheel puller and pull the wheel (Illus. No. 17).

4. With a chisel and hammer cut the six rivets holding the brake drum to the wheel hub and drive out the rivets.

5. The drum can now be removed.

6. Reverse operations to replace.

Bolt the drum in place on the hub using two bolts opposite each other in the rivet holes. This will hold the drum in place while the rivets are being installed. Heat the rivets, do not attempt to install them cold.

Tools Required—Jack, hub cap wrench, pliers, screw driver, No. 23 and 29 open end wrenches, axle shaft nut wrench, wheel puller, chisel and hammer.

ARTICLE NO. 26

To Remove and Replace Wood Wheel Brake Drum

1. Remove the rear wheel. (See Operation Article No. 42, Vol. 1, or use the following operations):

A. Place a jack under the axle and raise until the wheel where drum is to be removed clears the floor.

B. Unscrew the hub cap.

C. Remove the cotter pin and unscrew the axle shaft nut (Illus. No. 16).

D. Screw on the wheel puller and pull the wheel. (Illus. No. 17).

2. File off the peened ends of the twelve hub bolts "A" (Illus. No. 21).

3. Remove the nuts from the hub bolts and drive out the bolts.

4. The brake drum can now be removed.

5. Reverse operations to assemble using new bolts and nuts.

Tools Required—Jack, hub cap wrench, pliers, wheel puller, axle shaft nut wrench C.O. 275, file, hammer, drift and No. 27 open end wrench.

ARTICLE NO. 27

To Remove and Replace Parking Brake Band

1. Remove the clevis pin at "H" (Illus. No. 1).

2. Remove adjusting nut "C" (Illus. No. 5).

3. Remove adjusting screw "B" (Illus. No. 5).

4. Slide off the release bracket on the left-hand side of the band, holding the hand over the bracket to avoid losing the two small release springs.

5. Pull down the threaded bolt attached to lever "D" and remove the brake band assembly and also spring "B".

6. Reverse operation to replace.

7. Adjust the brake band as described in Operation Article No. 37.

Tools Required—No. 33 open end wrench, adjustable wrench, pliers.

ARTICLE NO. 28

To Reline Parking Brake Band

1. Remove the parking brake band. (See Operation Article No. 27).

2. With a chisel cut off the rivets holding the lining to the band, being careful not to spring the brake band.

3. Place new lining on the band and drill a rivet hole at one end.

4. Countersink the hole in the lining to the size of the rivet head, insert rivet and head it over. Be sure that the rivet head is pulled well into the lining to prevent rubbing the brake drum.

5. Drill the other rivet hole in the same end of the lining and perform operation 4.

6. Drill each hole and head the rivet as in operation 4, one at a time, in succession.

7. Form .the brake band as given under C.O 418 Special Tool Section.

8. Replace the brake band. (See Operation Article No. 27).

9. Turn adjusting screw "B" (Illus. No. 5) until the clearance between the band and the drum is .015 of an inch.

10. Turn the lower adjusting nuts to give the same clearance to the lower half of the band. After making this adjustment be sure to tighten the lower nut against the upper one.

11. Adjust the upper half of the band by means of nut "C" until .015 of an inch clearance is obtained.

Tools Required—No. 33 open end wrench, adjustable wrench, pliers, cold chisel, punch, hammer, forming fixture C.O. 418, screw driver, No. 21 and 25 open end wrenches.

ARTICLE NO. 29

To Remove and Replace Parking Brake Drum

(Big and Special Six)

1. Take out the six bolts at the rear universal joint and unscrew the brass sleeve at the front end of the propeller shaft.

2. Remove the propeller shaft by dropping the rear end down and sliding the front end out of the splines.

3. If working on a bus chassis, remove the six bolts holding the front universal joint to the flange. Remove the four U-bolt nuts holding the propeller shaft support bearing to the frame cross member and lower the assembly to the floor.

4. Remove the clevis pin at "H" (Illus. No. 1).

5. Remove screw "B" (Illus. No. 5) from the parking brake release bracket.

6. Remove the two screws holding the brake band adjusting link spring bracket to the pump cover and take off the parking brake band assembly. Take care not to lose the two small coil springs at "B" (Illus. No. 5).

7. Remove the cotter pin and unscrew nut 'A" (Illus. No. 5).

8. The transmission shaft flange can be removed with Universal Puller C.O. 71 (See Vol. 8). The brake drum will be removed with the flange.

9. Reverse operations to assemble.

See Operation Article No. 37 to adjust the brake band.

Tools Required—No. 33 open end wrench, adjustable wrench, pliers, Universal Puller, C.O. 71, screw driver, hammer, No. 21 and 25 open end wrenches.

ARTICLE NO. 30

To Remove and Replace Parking Brake Drum

(Standard Six)

1. Remove the three bolts holding the propeller shaft to the universal flexible discs at the front and rear and remove the propeller shaft.

2. Remove the parking brake band. (See Operation Article No. 27).

3. Remove the cotter pin and unscrew nut "A" (Illus. No. 5).

4. The transmission shaft flange can be removed with Universal Puller C.O. 71. (See Vol. 8. The brake drum will be removed with the flange.

5. Reverse operations to assemble.

See Operation Article No. 37 to adjust the brake band.

Tools Required—No. 33 open end wrench, adjustable wrench, pliers, Universal Puller C. O. 71, screw driver, hammer, No. 21 and 25 open end wrenches.

ARTICLE NO. 31

To Disassemble and Assemble Service Brake Pump

(Big and Special Six)

(Hydraulic brake equipment)

1. Unlock and remove the large floor board.

2. Take out the two wood screws and remove the small floor board.

3. Take out the six bolts at the rear universal joint and unscrew the brass sleeve at the front end of the propeller shaft.

4. Remove the propeller shaft by dropping the rear end down and sliding the front end out of the splines.

5. If working on a bus chassis, remove the six bolts holding the front universal joint to the flange. Remove the four U-bolt nuts holding the propeller shaft support bearing to the frame cross member and lower the assembly to the floor.

6. Remove the clevis pin at "H" (Illus. No. 1).

7. Remove screw "B" (Illus. No. 5) from the parking brake release bracket.

8. Remove the two screws holding the brake band adjusting link spring bracket to the pump cover and take off the brake band assembly. Take care not to lose the two small coil springs at "B" (Illus. No. 5).

9. Remove the cotter pin and unscrew nut "A" (Illus. No. 5).

10. The transmission shaft flange can be removed with Universal Puller C. O. 71 (See Vol. 8). The parking brake drum will be removed with the flange.

11. Unscrew the speedometer cable at "I" (Illus. No. 1).
12. Unscrew the brake oil gauge pressure pipe at "J".
13. Remove the cotter pin and disconnect the pump valve rod from the valve.
14. Remove nut "C" (Illus. No. 7) and take out the speedometer pinion.
15. Remove the seven screws (Illus. No. 7 and take off pump cover "A".
16. Remove speedometer drive gear "G" (Illus. No. 8).
17. Pull off the pump drive gear "H" using Universal Puller C. O. 71. (See Vol. 8).
18. Remove the pump driven gear.
19. The pump housing can now be removed.
20. Reverse operations to assemble.

Make sure that the gaskets are in good condition and that the body and cover gaskets are not obstructing any oil passages.

In rebuilding the pump, assemble the parts as far as the transmission shaft flange, leaving off the brake drum. Draw the cover screws just tight enough to hold the cover in position. Rotate the transmission shaft to determine if the pump gears are free. If a binding action is noted tap the cover and housing slightly until such a position is reached that the transmission shaft turns freely. Then tighten the cover screws before removing the transmission shaft flange to replace the brake drum.

Make sure that cover screw "B" (Illus. No. 7) is the one with a pilot on the end. This pilot acts as a stop for the pump pistons.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, Universal Puller C.O. 71, hammer.

ARTICLE NO. 32

To Disassemble and Assemble Service Brake Pump

(Standard Six)

(Hydraulic brake equipment)

1. Unlock and remove the large floor board.
2. Take out the two wood screws and remove the small floor board.
3. Remove the three bolts holding the propeller shaft to the universal flexible discs at the front and rear and remove the propeller shaft.
4. Remove the parking brake band. (See Operation Article No. 27).
5. Remove the cotter pin and unscrew nut "A" (Illus. No. 5).
6. The transmission shaft flange can be removed with Universal Puller C.O. 71, (See Vol. 8). The brake drum will be removed with the flange.
7. Unscrew the speedometer cable at "I" (Illus. No. 3).
8. Unscrew the brake oil gauge pressure pipe at "J".
9. Remove the cotter pin and disconnect the pump valve rod from the valve rocker lever.
10. Remove nut "C" (Illus. No. 9) and take out the speedometer pinion.
11. Remove the screws holding the pump cover "A" (Illus. No. 9) and take off the pump cover.
12. Remove speedometer drive gear "G" (Illus. No. 10).
13. Pull off the pump drive gear "H" using Universal Puller, C. O. 71. (See Vol. 8).
14. Remove the pump driven gear.
15. The pump housing can now be removed.
16. Reverse operations to assemble.

Make sure that the gaskets are in good condition and that the body and cover gaskets are not obstructing any oil passages.

In rebuilding the pump, assemble the parts as far as the transmission shaft flange, leaving off the brake drum. Draw the cover screws just tight enough to hold the cover in position. Rotate the transmission shaft to determine if the pump gears are free. If a binding action is noted tap the cover and housing slightly until such a position is reached that the transmission shaft turns freely. Then tighten the cover screws before removing transmission shaft flange to replace the brake drum.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, Universal Puller C.O. 71, hammer.

ARTICLE NO. 30-1

To Remove and Replace Parking Brake Drum

(*Standard Six*)

The following revision in Article No. 30 applies to Standard Six cars equipped with spicer universal joints.

1. Remove the six bolts holding the rear universal joint to the drive flange and unscrew the sleeve packing nut at the front end of the propeller shaft.
2. Remove the propeller shaft by dropping the rear end down and sliding the front end out of the splines.
3. Remove the six bolts holding the front universal joint to the drive flange and remove the universal.
4. Remove the cotter pin and unscrew nut "A" (Illus. No. 5).
5. The transmission shaft flange can be removed with Universal Puller C. O. 71. (See Vol. 8). The drum can then be lifted out.
6. Reverse operations to assemble.

See Operation Article No. 37 to adjust the brake band.

Tools Required—No. 33 open end wrench, adjustable wrench, pliers, Universal Puller C. O. 71, screw driver, hammer, No. 21 and 25 open end wrenches.

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ARTICLE NO. 33

To Remove and Replace Service Brake Pump Piston

1. Remove clevis pin "E" (Illus. No. 1) on the side which is being worked on.
2. Take out the four caps screws holding the cylinder cover to the case.
3. The cylinder cover and piston can now be removed.
4. Reverse operations to replace.

See that the packing nut is not drawn so tight that it binds, preventing free movement of piston.

Tools Required—Pliers, ½ inch socket wrench, adjustable wrench.

ARTICLE NO. 34

To Remove and Replace Rear Wheel Brake Band

1. Remove the rear wheel. (See Operation Article No. 41, Vol. 1, or use the following operations):
   - A. Place a jack under the rear axle and raise until the wheel to be removed clears the floor.
   - B. Unscrew the hub cap.
   - C. Pull the cotter pin and unscrew the axle shaft nut (Illus. No. 17).
   - D. Screw on the wheel puller and pull the wheel (Illus. No. 17).
2. Remove the two adjusting screws "A" and "C" (Illus. No. 18).
3. Remove the clevis pin connecting the brake rod to the bell crank.
4. Remove upper adjusting nut "D" (Illus. No. 18).
5. Pull out brake adjusting link "G" and remove the spring.
6. Slide off the band and bell crank assembly, holding the hand over the rear bracket at "A" to prevent the two small release springs from flying out.
7. Reverse operations to assemble.
8. Adjust the brake band. (See Operation Article No. 38).

Tools Required—Jack, hub cap wrench, pliers, axle shaft nut wrench C.O. 275, wheel puller, No. 23, 27 and 31 open end wrenches, hammer.

ARTICLE NO. 35

To Remove and Replace Rear Brake Shoes on Bus Dual Wheel Equipment

1. Place a jack under the rear axle, on the side where the shoes are to be removed, and raise until the wheel clears the floor.
2. Remove the nuts holding the wheel discs to the hub and remove the discs. The nuts on the left-hand side have a left-hand thread and on the right-hand side a right-hand thread.
3. Unscrew the hub cap.
4. Pull the cotter pin and remove the axle shaft nut.
5. Screw on a wheel puller and pull the wheel hub. This operation on a wood wheel is shown in Illus. No. 17.
6. Remove the cotter pins and flat washers from pins "C" (Illus. No. 24).
7. Remove spacer bolts "L" and "M" (Illus. No. 24) together with spacers, springs and washers.
8. Remove screw and washer "J".
9. Remove both brake shoes at once leaving spring "K" fastened to the shoes.
10. After the shoes are removed, unfasten spring "K".
11. Reverse operations to assemble.

Note—Be sure to mount the brake shoes on the same pin "C" (Illus. No. 25) from which they were removed.

Tools Required—Jack, hub cap wrench, large socket for disc wheel nuts, wheel puller, pliers, screw driver, No. 25 and 29 open end wrenches.

ARTICLE NO. 36

To Reline Rear Wheel Brake Band

1. Remove the brake band. (See Operation Article No. 34).

2. With a chisel cut off the rivets holding the lining to the band, being careful not to spring the brake band.

3. Place new lining on the band and drill a rivet hole at one end.

4. Countersink the hole in the lining to the size of the rivet head, insert the rivet and head it over. Be sure that the rivet head is pulled well into the lining to prevent it from rubbing the brake drum.

5. Drill the other rivet hole in the same end of the lining and perform operation 4.

6. Drill each hole and head the rivet as in operation 4, one at a time, in succession.

7. Press the band together at points "A" and "B" (Illus. No. 20) to make it slightly oval in shape.

8. Assemble the bell crank and adjusting link to the band.

9. Clamp forming fixture, C.O. 416 (See Vol. 8) in a vise and slip the brake band over the large end.

10. Screw on the large adjusting nut "A" (Illus. No. 20) and tighten it until the band is just a snug fit on the fixture.

11. With light blows of a hammer strike the band at all points around its circumference.

12. Remove the band and if it is still slightly distorted put it on the fixture again and repeat operation 11.

13. Replace the brake band.

14. Adjust the brake. (See Operation Article No. 38).

Tools Required—Jack, hub cap wrench, pliers, wheel puller, axle shaft nut wrench C. O. 275, forming fixture C.O. 416, No. 23, 27 and 31 open end wrenches, cold chisel, punch, hammer.

ARTICLE NO. 37

To Adjust Parking Brake

1. Unlock and remove the large floor board.

2. Remove two wood screws and remove the small floor board.

3. Turn adjusting screw "B" (Jllus. No. 5) until the clearance between the band and drum is 1/32 of an inch.

4. Turn the lower adjusting nuts to give the same clearance to the lower half of the band.

After making this adjustment be sure to tighten the lower nut against the upper one.

5. Adjust the upper half of the band by means of nut "C" (Illus. No. 5) until 1/32 of an inch clearance is obtained.

Tools Required—No. 21, 25 and 33 open end wrenches, adjustable wrench, pliers.

ARTICLE NO. 38

To Adjust Rear Wheel Brake

1. Loosen the nuts at the foot brake pedal adjustment and screw the pedal in or out of the pedal arm so that the clearance between the pedal pad and toe board is 5 inches.

The brake pedal arm should not be closer than 1/8 of an inch to the under side of the toe board. If it is closer than this adjust the stop screw at the lower end of the pedal to give proper clearance.

Then readjust to obtain the 5 inch pedal clearance as instructed above.

2. Tighten the pedal adjusting lock nuts.

3. The foot brake front rod must be so adjusted that it is perfectly straight.

ARTICLE NO. 37-1

To Adjust Parking Brake

The following revision in Article No. 37 *applies to Commander cars after serial number* 4,062,101 *and Dictator cars after serial number* 1,437,601.

1. Unlock and remove the large floor board.
2. With the brakes released, turn the adjusting screw "L" (Illus. No. 54) until the clearance between the band and drum is 1/32 of an inch measured at the bottom.
3. Turn the adjusting screw "H" until the clearance between the band and drum is 1/32 of an inch measured at the side.
4. Adjust the upper half of the band by turning nut "D" until the clearance between the band and drum is 1/32 of an inch.
5. Replace floor board.

Tools Required—No. 21 and 25 open end wrenches, screw-driver and pliers.

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A bow in this rod might be caused from too much tension on the return spring. If excessive tension is required on this spring to release the brakes, the cross shafts or bell crank clevis pins should be freed up to permit normal operation.

4. Examine the brake bands to see if they are round. If they are found to be distorted proceed with the following operations. If they seem perfect skip to operation No. 13.

5. Remove the brake band. (See Operation Article No. 34).

6. After removal reassemble the helical spring and adjusting nut to the band.

7. Press the band together at points "A" and "B" (Illus. No. 20), to make it slightly oval in shape.

8. Clamp forming fixture C.O. 416 (See Vol. 8) in a vise and slip the brake band over the end of the fixture which fits the band.

9. Tighten large adjusting nut "A" (Illus. No. 20), until the band is just a snug fit on the fixture.

10. With light blows of a hammer strike the band at all points around its circumference.

11. Remove the band. If it is still slightly distorted, repeat operations 9 and 10.

12. Replace the brake band on the car.

13. Leave the clevis pin at the rear end of the brake rods out until the band adjustment is completed.

14. Turn adjusting screw "A" (Illus. No. 18) until the clearance between the brake band lining and the drum at this point is .015 of an inch.

15. Turn lower nuts "B" to give the same clearance to the lower half of the band. Turning these nuts up loosens the band and turning them down tightens it. After making the adjustments be sure the lower nut is locked against the upper one.

16. Turn adjusting screw "C" to give .015 of an inch clearance.

17. Turn adjusting nut "D" so that the end of the upper half of the band is free and clearance of .015 of an inch is maintained around the band. If necessary, make slight adjustments by means of screw "C" to give uniform clearance.

18. Turn the adjusting clevises on the brake side rods so that when connected in place any lost motion will be taken out of the bell cranks without disturbing the position of the brake bands.

19. With the rear wheels clear of the floor, check the clearance between the brake band and drum with a .015 of an inch feeler gauge. The gauge should pass entirely around the drum with a snug fit at all points.

20. Remove the jacks under the rear axle.

Tools Required—Jacks, screw driver, pliers, Forming Fixture C.O. 416, No. 25 and 31 open end wrenches, hammer, brake band adjusting link lower nut wrench C.O. 420, .015 of an inch feeler gauge.

ARTICLE NO. 39

To Adjust Service Brakes on Bus Dual Wheel Equipment

1. Place jacks under the rear axle and raise until the wheels clear the floor.

2. In cases where the linings are worn considerable it may be necessary to take out the clevis pin at "U" (Illus. No. 23) on each side and move it to the next clevis pin hole in order to obtain the necessary amount of take up. After moving the pin make sure the wheels turn freely.

3. Have the foot brake pedal gradually applied by someone in the front seat, until one of the rear wheels offers some resistance to being turned. With the brake pedal held in this same position try the other rear wheel. It should turn with the same amount of effort.

4. If the brakes are not equal, loosen the lock nut and remove the clevis pin at "T" (Illus. No. 23). Tighten the adjusting clevis on the loose side one turn or not more than two turns. If they are still unequal loosen the clevis on the tight side one turn or not more than two turns. This will equalize the brakes.

Tools Required—Jacks, pliers, No. 25 open end wrench, hammer.

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ARTICLE NO. 40

To Adjust 4-Wheel Mechanical Brakes

1. Inspect the brake pedal arm to see that it does not come closer than ⅛ of an inch to the under side of the toe board. If it is closer than this, or if the clearance is more than ¼ of an inch, remove the clevis pin connecting it to the brake rod and adjust the clearance by means of the adjusting screw in the lower part of the arm.

2. Loosen the nuts holding the pedal pad in the pedal arm and adjust the clearance between the pedal pad and the toe board to 5½ inches. Then tighten the nuts.

3. See that the center equalizer is free to go back against the stops and then connect the center brake rod to the brake pedal. If necessary move the adjustable clevis at the front end of the rod enough to permit making the connection without buckling the rod or pulling the equalizer away from the stops.

4. Adjust the stop screws on the frame side members so as to bring the outside ends of the two brake cross shafts approximately in the center of the holes in the frame side members.

5. Place jacks under the rear axle housing raising until the rear wheels are clear of the floor.

6. Adjust the rear wheel brake bands as described in Operation Article No. 38, operations 4 to 20 inclusive.

7. Before adjusting the front brakes it is advisable to check the cam support adjustment as described in Operation Article No. 21, operation 7.

8. Turn the adjustable clevises on the front brake rods so that when the clevises are fastened to the levers, the front brakes will be applied as much as possible without actually rubbing the drums.

The clevises will ordinarily be fastened in the lower hole of the front brake long lever. However, if this position makes the front brakes more active than is desired, the clevises may be moved up to one of the other two holes.

Tools Required—Jacks, screw driver, pliers, Forming Fixture C. O. 416, No. 25 and 31 open end wrenches, hammer, .015 of an inch feeler gauge.

ARTICLE NO. 41

To Remove and Replace Dove Tails on Custom Bodies

1. Push the ends of a pair of long nosed pliers or a screw driver between the side of the spring and the rubber bumper and force the ends of the spring out of the casing. (See Illus. No. 42, fig. 1 and 2).

2. Place the screw driver back of the spring and force it out of place. (Fig. 3).

3. Force the screw driver under the front edge of the rubber bumper and pry it out of place. (Fig. 4).

4. To replace bumper and spring, reverse the operations.

Tools Required—Pair of long nosed pliers and a screw driver.

ARTICLE NO. 42

To Remove and Replace Windshield Regulator Guide Blocks on Custom Bodies

1. Move the windshield to the extreme outer position.

2. Remove one screw from the guide channel and loosen the other one. The channel may now be swung upward, which will release the regulator arms and blocks. The windshield may now be swung outward and held up by means of a short prop.

3. Remove the old blocks and install the new ones being careful to see that the side of the block that is faced off at the bottom is put next to the spring.

4. Reverse operations to replace.

Tools Required—Screw driver and short prop.

ARTICLE NO. 40-1

To Adjust Four Wheel Mechanical Brakes

The following revision in Article No. 40 applies to Custom Cars having brake stops located at the rear brake bell crank.

1. Inspect the brake pedal arm to see that it does not come closer than 1/8 of an inch to the under side of the toe board. If it is closer than this, or if the clearance is more than 1/4 of an inch, remove the clevis pin connecting it to the brake rod and adjust the clearance by means of the adjusting screw in the lower part of the arm.

2. Loosen the nuts holding the pedal pad in the pedal arm and adjust the clearance between the pedal pad and the toe board to 5 1/2 inches. Then tighten the nuts.

3. See that all the brake rods are working freely and that the rear brake rod bell cranks go back against the stops, which are now located on the rear axle brake spring brackets. If the bell cranks become bent or for any reason do not line up with the stops, they should be bent into shape before any further brake adjustment is made.

If necessary, move the adjustable clevis at the front end of the rod enough to permit making the connection to the brake rod without buckling the rod or pulling the bell cranks away from the bracket stops.

4. Adjust the stop screws on the frame side members so as to bring the outside ends of the two brake cross shafts approximately in the center of the holes in the frame side members.

5. Place jacks under the rear axle housing raising until the rear wheels are clear of the floor.

6. Adjust the rear wheel brake bands as described in Operation Article No. 38, operations No. 4 to 20 inclusive.

7. Before adjusting the front brakes it is advisable to check the cam support adjustments as described in Operation Article No. 21, operation 7.

8. Turn the adjustable clevises on the front brake rods so that when the clevises are fastened to the levers, the front brakes will be applied as much as possible without actually rubbing the drums.

The clevises will ordinarily be fastened in the lower hole of the front brake long lever. However, if this position makes the front brakes more active than is desired, the clevises may be moved up to one of the other two holes.

Tools Required—Jack, screw driver, pliers, Forming Fixture C. O. 416, No. 25 and 31 open end wrenches, hammer, .015 of an inch feeler gauge.

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PRINTED IN U. S. A.

ARTICLE NO. 40-2

To Adjust the Service Brakes

The following revision in Article No. 40 *applies to Commander cars after serial number* 4,039,801.

1. Jack up all four wheels to clear the floor. Check the front and rear main spring clips, to see that they are tight to prevent any movement of the axles, relative to the springs or brake operating rods. Also make sure that the brake cross shafts, rods and clevises are working freely.

2. Check the front wheel bearings for looseness (See Vol. 1) or use the following operations:

A. Tighten the adjusting nut, at the same time turning the wheel with one hand while tightening, to allow the bearing to seat properly.

B. Then back off the adjusting nut until the wheel turns freely but has a minimum amount of side-play.

3. Check the rear axle shafts for endplay, if they have excessive endplay (See Vol. 1) or use the following operations:

A. Pull the wheel and remove the adjusting flange.

B. There are shims of .005, .010 and .030 of an inch thickness at each end of the axle housing. Adjustment should be made from both ends when more than two shims need to be removed. It is advisable to have about .003 of an inch endplay to make sure that the shafts do not bind.

4. Loosen eccentric lock nut "C" (Illus. No. 54) and back off slightly to make sure the brake is not binding.

5. See that the carrier bracket "K" (Illus. No. 51) is sufficiently free to allow the operating cam to center itself between the primary and auxiliary shoes when the brakes are applied.

6. Loosen the anchor pin nuts free of the lock washers. Apply the brake with a Stillson wrench on the control shaft or use a brake applying wrench on the control lever.

7. Tap the anchor pins "D" (Illus. No. 52) out, holding the brake on tight, try to turn the wheel forward.

8. Holding the brake on, tighten both anchor pin nuts as tight as possible with a 16 inch wrench.

9. Release the brake and set the eccentric adjustment as follows: Turn the eccentric "D" (Illus. No. 52) in direction the wheel revolves when the car moves forward, until secondary shoe is tight against the drum. Then back off gradually until wheel is just free. Tighten the lock nut "C" to hold the adjustment in this position. Care must be taken that the eccentric does not turn while tightening the lock nut.

10. The angle of the control lever with the brake rod should be 70° with the brakes released. If not this angle, reset as follows: Loosen the clamp bolt "L" (Illus. No. 52) and slide off the serrations. Slack off rod adjusting nut "J" to end of the threads on the brake rod. Apply brake with Stillson wrench on camshaft "R" and slip control lever onto serrations. If brake is too tight move lever back one serration. Tighten clamp bolt. *Control levers should have approximately the same angle with the rod on all four brakes.*

11. Take up on the rod adjusting nut "J" until wheel just drags, then back off until wheel turns free.

12. Remove the brake drum feeler hole cover "A" (Illus. No. 49) so that feeler gauge may be inserted between the shoe lining and the brake drum. With the brakes released check the clearance at the toe and the heel of the auxiliary shoe "B" (Illus. No. 43) and secondary shoe "C". Both ends of the same shoe must be alike within .002 of an inch.

Note—It is recommended that the heel of the shoes be set with the same clearance as the toe or from .000 to .002 of an inch closer, that is, if the toe is set with .010 of an inch clearance set the heel as near .008 of an inch as possible.

If not within these limits repeat the anchor pin adjustment, or loosen the improperly set anchor and tap until correct clearance is obtained, tighten anchor pin and replace feeler hole cover.

Repeat the above operations on the other wheels of the car.

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PRINTED IN U. S. A.

13. To equalize the brakes hold the brake pedal down with a block or pedal jack until the tightest wheel can just be turned by hand. Slack off the rod adjusting nut ½ turn at a time on the tightest wheels until all four offer the same resistance, remembering that a change in the rear brake may affect the front brake on the same side and vice versa.

14. Release the brake pedal and try all four wheels for drag. There should be no drag if previous operations were properly performed.

15. Remove jacks or blocking from under car.

16. Test the car on the road or shop floor to see that all four brakes are equalized with the car in motion.

Tools Required—Jacks or suitable material to block car off floor, Stillson wrench, brake applying wrench, No. 25 and 29 open end wrenches, 16 inch anchor nut wrench, pedal jack, feelers, screwdriver and pliers.

ARTICLE NO. 40-3

To Adjust the Service Brakes

The following revision in Article 40 *applies to Dictator cars after serial number* 1,410,001.

1. Jack up all four wheels to clear the floor. Check the front and rear main spring clips, to see that they are tight to prevent any movement of the axles, relative to the springs or brake operating rods. Also make sure that the brake cross shafts, rods and clevises are working freely.

2. Check the front wheel bearings for looseness See Vol. 1) or use the following:

A. Tighten the adjusting nut, at the same time, turning the wheel with one hand while tightening, to allow the bearing to seat properly.

B. Then back off the adjusting nut until the wheel turns freely but has a minimum amount of sideplay.

3. Check the rear axle shafts for endplay, if they have excessive endplay, (See Vol. 1), or use the following operations:

A. Pull the wheel and remove the adjusting flange.

B. There are shims of .005, .010 and .030 of an inch thickness at each end of the axle housing. Adjustment should be made from both ends when more than two shims need to be removed. It is advisable to have about .003 of an inch endplay to make sure that the shafts do not bind.

4. Loosen eccentric lock nut "C" (Illus. No. 52) and back off eccentric "D" slightly to make sure the brake is not binding.

5. Loosen the anchor pin nuts free of the lock washers. Apply the brake with a Stillson wrench on the camshaft or use a brake applying wrench on the control lever.

6. Tap the anchor pins out, holding the brake on tight, try to turn the wheel forward.

7. Holding the brake on, tighten both anchor pin nuts as tight as possible with a 16 inch wrench.

8. To adjust the front wheel brakes, release the brakes, turning the rod adjusting nut "J" (Illus. No. 52) until the center line of the ball on lever "K" is ¼ to $\frac{5}{16}$ of an inch back of the center line of the king pin.

9. If brake shoes are tight, loosen lock nut on the worm screw adjustment and turn the slot to the right until brake shoes are free. If brakes have the adjusting screw "S" loosen lock nut and turn until the brake shoes are free. If the threads are all used on the set screw "S" loosen the clamp bolt "L" and reset the cam lever "R" on the camshaft serrations.

10. Loosen the lock nut "C" and turn the eccentric "D" in same direction in which the wheel revolves when car moves forward, until the brake is tight against the drum, then back off gradually until wheel is just free. Hold the eccentric and tighten the lock nut in this position.

11. Turn the worm screw or set screw "S" until the brake binds, then back off until the brake is just free.

12. To adjust the rear wheel brakes, loosen the eccentric lock nut and turn the eccentric in the same direction in which the wheel revolves when car moves forward, until the brake is tight against the drum, then back off gradually until wheel is just free. Hold eccentric and tighten lock nut.

13. The angle of the control lever with the brake rod should be approximately 70° with the brakes released. If not this angle, reset as follows: Loosen the pinch bolt "F" (Illus. No. 48) and slide the cam lever off the serrations. Slack off the

rod adjusting nut "D" to end of the threads on the brake rod. Apply the brake with a Stillson wrench on the camshaft and slip control lever on the camshaft. If the brake is too tight move the control lever back one serration. *Tighten the pinch bolt. Control levers should have approximately the same angle with the rod on all four brakes.*

14. Take up on the rod adjusting nut "J" until wheel just drags, then back off until wheel turns free.

15. Remove the brake drum feeler hole cover "A" (Illus. No. 49) so that feeler gauges may be inserted between the shoe lining and the brake drum. With the brakes released check the clearance at the toe and the heel of the auxiliary shoe "B" (Illus. No. 51) and secondary shoe "C" both ends of same shoe must be alike within .002 of an inch.

Note—It is recommended that the heel of the shoe be set with the same clearance as the toe or from .000 to .002 of an inch closer, that is, if the toe is set with .010 of an inch clearance set the heel as near .008 of an inch as possible. If not within these limits repeat anchor pin adjustment, or loosen the improperly set anchor and tap until correct clearance is obtained, tighten anchor pin and replace feeler hole cover.

Repeat the above operations on the other wheels.

16. To equalize the brakes hold the brake pedal down with a block or pedal jack until the tightest wheel can just be turned by hand. Slack off the rod adjusting nut ½ turn at a time on the tightest brakes until all four offer the same resistance, remembering that a change in the rear brake may effect the front brake on the same side and vice versa.

17. Release the brake pedal and try all four wheels for drag. There should be no drag if previous operations were properly performed.

18. Remove jacks or blocking from under car.

19. Test the car on the road or shop floor to see that all four brakes are equalized with the car in motion.

Tools Required—Jacks or suitable material to block car off floor, Stillson wrench, brake applying wrench, No. 25 and 29 open end wrenches, 16 inch anchor nut wrench, pedal jack, feelers, screwdriver and pliers.

Issued July 1st, 1929
Insert in Volume Two, after page 68-B-1.
PRINTED IN U. S. A.

ARTICLE NO. 43

To Remove and Replace Door Hinges on Custom Bodies

1. Remove the garnish moulding around the opening in the door by removing the screws through the door frame.

2. Remove the glass channel at the top of the door and pull the side window runs up through the opening in the top of the door frame.

3. Raise and remove the window glass.

4. If the lower hinge is to be replaced the upholstery will have to be partly removed.

5. Remove the machine screws in the door hinge, cut off the rivet heads and remove the hinge. (See Illus. No. 39). Remove any burrs at the door frame.

6. Install the machine screws in the new hinge and see that the door is lined up. Install ¼ x ¾ of an inch countersink rivets and file the heads off flush.

Note—A door hinge bending iron for lining up the door is listed in the Service Tool Catalog.

7. Replace the door glass and the trimming.

Tools Required—Screw driver, pliers, hammer, cold chisel, file and door hinge bending iron.

ARTICLE NO. 44

To Adjust Door Checks on Custom Bodies

1. Before attempting the adjustment of the checks, it is necessary that the proper clearance be obtained at all points, between the door flange and the body panel, when the door is closed. This can be accomplished by grasping the top of the door at the lock pillar and springing it in the desired direction against pressure applied at the lower part of the door. Care must be taken, in this operation, that the finish is not scratched or the door panel dented.

2. Loosen the trimming at the lower part of the door and turn it back to expose the spring adjustment of the lower check.

3. Swing the door to such a position that there is a clearance of one and one-half inches between the upper check link ball and the check spring seat as shown in illustration No. 41.

4. Loosen the lock nut on the lower check cable and turn the adjusting nut to such a position that the nut is holding the spring firmly but not compressing it.

5. Tighten the lock nut and open the door until the check springs are compressed.

If the adjustment is correct the springs of both checks will be fully compressed at the same point in the movement of the door.

Tools Required—Screw driver, pliers, adjustable wrench.

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PRINTED IN U. S. A.

ARTICLE NO. 43-1

To Remove and Replace Upper Door Hinge

The following revision in Article No. 43 applies to Commander and Dictator cars having custom bodies.

1. Remove the garnish moulding and loosen the window run at the top of the door.
2. Center punch and drill out the two rivets in the door frame.
3. Remove the four screws in the door pillar and the two in the door frame and remove the hinge.
4. Put the new hinge in position and replace the screws.
5. Replace the rivets with screw bolts and nuts being sure to use shake proof lock washers under the nuts.
6. Replace the window run and the garnish moulding.

Tools Required—Screw-driver, drill, hammer, center punch and pliers.

To Remove and Replace Lower Door Hinge

1. Remove the garnish moulding, remote control handle, butterfly and window regulator handle.
2. Unsnap the door trimming and remove.
3. Center punch and drill out the two rivets in the door frame.
4. Remove the four screws in the door pillar and the two in the door frame and remove the hinge.
5. Put the new hinge in position and replace the screws.
6. Replace the rivets with screw bolts and nuts being sure to use shake proof lock washers.
7. Replace the door trimming, hardware and garnish moulding.

Tools Required—Screw-driver, drill, center punch, remote control wrench, hammer and pliers.

ARTICLE NO. 44-1

To Remove and Replace Door Check Straps

The following revision in Article No. 44 applies to cars having the non-adjusting check straps.

1. Remove the door fitting on the door from which the check strap is to be removed. (See Operation Article No. 48).
2. Remove the door garnish moulding.
3. Unsnap the door trimming on the lock side and bottom and fold back.
4. Loosen quarter trimming around check strap.
5. Remove the four screws holding the check strap in place on the door pillar post.
6. The check strap can now be removed by pushing out through the door lock board.
7. Reverse operations to assemble.

Tools Required—Screw-driver, small center punch, remote control wrench.

Issued June 1, 1929
Insert in Volume Two, after page 68-C
PRINTED IN U. S. A.

ARTICLE NO. 45

To Remove and Replace Door Glass

1. Remove the door glass garnish moulding screws and remove the moulding.
2. Remove the rivets in the top of the door frame that holds the side window runs in place. If metal lined window runs are used remove the four rivets (2 on each side) holding the glass runs in place.
3. Run the window up to approximately ½ inch from the top of the door. Take hold of the glass from the inside of the door and tilt towards the inside until the top of the glass clears the top of the door. (See Illus. No. 18 President Eight Section). Then turn regulator handle until regulator arm appears about 1½ inch above the door. The stud on the regulator arm is flattened on one side and by tilting the glass the channel guide will spring off the flat portion of the guide.
4. The glass can now be pulled up through the glass runs and removed.

Note—In case the regulator arm cannot be run up past the lock board, spring the lock board out at the top just enough to clear the regulator arm roller rivet.

Tools Required—Screw-driver and rubber mallet.

ARTICLE NO. 46

To Remove and Replace Quarter Glass

1. Remove the quarter glass garnish moulding screws and remove the moulding.
2. Remove the trim stick in upper rear corner.
3. Run the glass up and pull out of the weather strips. Move the glass slightly to release the regulator arm and lift out.
4. Reverse operations to replace.

Tools Required—Screw-driver and rubber mallet.

ARTICLE NO. 47

To Remove and Replace Back Glass

1. Remove the back glass garnish moulding screws and remove the moulding.
2. The glass and rubber binding can now be pushed out to the inside. Care must be taken not to break the glass.
3. Reverse operations to replace.

Note—To prevent water leaks the glass and rubber retainer should be a snug fit in the window opening to prevent the retainer from pulling away from the glass. If necessary place a cardboard shim between the rubber retainer and window opening when placing the glass and retainer in position. The glass should then be sealed in place with dum dum putty.

Tools Required—Screw-driver and rubber mallet.

ARTICLE NO. 48

To Remove and Replace Door Fittings

1. Remove the remote control (inside door handle) by pushing the remote control wrench between the washer and handle and loosening the fastening nut. (See Illus. No. 19 President Eight Section).
2. Take out the small screw which holds the door lock butterfly in position.
3. Press back the washer "D" and punch the small pin out which holds the regulator handle in place and remove the handle.
4. Reverse operations to replace.

Tools Required—Screw-driver, small punch and remote control wrench.

Issued June 1, 1929
Insert in Volume Two, after page 68-E
PRINTED IN U. S. A.

ARTICLE NO. 49

To Remove and Replace Robe Rail

1. Remove the front seat cushion.
2. Remove the tacks which hold the bottom of the front seat back trimming in place and raise the front seat back trimming.
3. Remove the nuts holding the robe rail in place and remove the robe rail.
4. Reverse operations to replace.

Tools Required—Trimmers hammer, screw-driver and pliers.

ARTICLE NO. 50

Refitting the Doors

1. If the door rides the roof rail and has too wide an opening at the lower hinge, bend the bottom hinge in with bending iron.
2. If the door rides the sill, bend the upper hinge in with bending iron.
3. If door is too tight at the hinge side, close each hinge on a solid object as a screw-driver or punch, which will throw the door away from the hinge pillar.
4. If the opening is too small at the center post, bend both hinges in with bending iron.
5. If the door flanges strikes the center post, install longer rubber bumpers or put a shim behind the old bumper.
6. If the door flange hits only at the top or bottom due to its being bent, it can be bumped back, care being taken that it is well supported when bumping so that the panel will not loosen from the door frame.

Tools Required—Bending iron, screw-driver and rubber mallet.

(Remove and Destroy Old Specifications)

BODY COLOR SPECIFICATIONS

The following pages give the color combinations of all Studebaker custom cars built after serial numbers, 1,346,101, 2,102,301, 4,000,001, 5,000,001 and 6,000,001. They are to be used in connection with the Color Chart given in the Illustration section of the Service Reference Library.

Each body type has been placed on a separate sheet. Distributors and dealers not in possession of a Service Reference Library should file these sheets in a binder for permanent record.

Body color specification sheets are being discontinued, as effective in production on February 1, 1928 the color combination, with which the body is finished above and below the moulding and belt panel, is stenciled in the body on the rear seat board in the tourer, victoria, club sedan and sedan bodies and under the front seat in coupe and roadster bodies.

PRESIDENT EIGHT SEDAN
7-Passenger (FA-W1)

Above Moulding—No. 294 Sable Lacquer.

Below Moulding—No. 294 Sable Lacquer.

Belt Panel—No. 580 Dauphin Red Lacquer.

Mouldings—No. 294 Sable Lacquer.

PRESIDENT EIGHT SEDAN
7-Passenger (FA-W2)

Above Moulding—No. 3019 Spruce Green Lacquer.

Below Moulding—No. 3019 Spruce Green Lacquer.

Belt Panel—No. 4024 Dove Gray Lacquer.

Mouldings—No. 3019 Spruce Green Lacquer.

PRESIDENT EIGHT SEDAN
7-Passenger (FA-W3)

Above Moulding—No. 4046 Damson Plum Lacquer.

Below Moulding—No. 4046 Damson Plum Lacquer.

Belt Panel—No. 4045 Beech Gray Lacquer.

Mouldings—No. 4046 Damson Plum Lacquer.

PRESIDENT EIGHT LIMOUSINE
7-Passenger (FA-M)

Above Moulding—No. 294 Sable Lacquer.

Below Moulding—No. 294 Sable Lacquer.

Belt Panel—No. 580 Dauphin Red Lacquer.

Mouldings—No. 294 Sable Lacquer.

PRESIDENT EIGHT SEDAN
5-Passenger (FA-S1)

Above Moulding—No. 294 Sable Lacquer.

Below Moulding—No. 294 Sable Lacquer.

Belt Panel—No. 580 Dauphin Red Lacquer.

Mouldings—No. 294 Sable Lacquer.

PRESIDENT EIGHT SEDAN
5-Passenger (FA-S2)

Above Moulding—No. 3019 Spruce Green Lacquer.

Below Moulding—No. 3019 Spruce Green Lacquer.

Belt Panel—No. 4024 Dove Gray Lacquer.

Mouldings—No. 3019 Spruce Green Lacquer.

PRESIDENT EIGHT SEDAN
5-Passenger (FA-S3)

Above Moulding—No. 4046 Damson Plum Lacquer.

Below Moulding—No. 4046 Damson Plum Lacquer.

Belt Panel—No. 4045 Beech Gray Lacquer.

Mouldings—No. 4046 Damson Plum Lacquer.

(Remove and Destroy Old Specifications)

PRESIDENT LIMOUSINE
Big Six 127 inch W. B. (ES-U, ES-Z)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 690 Black Lacquer.
Between Moulding—No. 690 Black Lacquer.
Upper Moulding—No. 2963 Thistle Green Lacquer.
Lower Moulding—No. 2963 Thistle Green Lacquer.

PRESIDENT LIMOUSINE
Big Six 127 inch W. B. (ES-M)

Above Moulding—No. 428 Tulsa Gray Lacquer.
Below Moulding—No. 288 Arizona Brown Lacquer.
Between Mouldings—No. 288 Arizona Brown Lacquer.
Upper Moulding—No. 428 Tulsa Gray Lacquer.
Lower Moulding—No. 428 Tulsa Gray Lacquer.

PRESIDENT LIMOUSINE (DELUXE)
Big Six 127 inch W. B. (ES-K)

Above Moulding—No. 428 Tulsa Gray Lacquer.
Below Moulding—No. 288 Arizona Brown Lacquer.
Between Moulding—No. 288 Arizona Brown Lacquer.
Upper Mouldings—No. 428 Tulsa Gray Lacquer.
Lower Mouldings—No. 428 Tulsa Gray Lacquer.

PRESIDENT LIMOUSINE (DELUXE)
Big Six 127 inch W. B. (ES-M)

Above Moulding—No. 294 Modoc Brown Lacquer.
Below Moulding—No. 290 Hopi Drab Lacquer.
Between Moulding—No. 290 Hopi Drab Lacquer.
Upper Moulding—No. 294 Modoc Brown Lacquer.
Lower Moulding—No. 294 Modoc Brown Lacquer.

PRESIDENT LIMOUSINE
Big Six 127 Inch W. B. (ES-W)

Above Moulding—No. 3015 Croatan Green Lacquer.
Below Moulding—No. 3009 Catona Green Lacquer.
Between Moulding—No. 3009 Catona Green Lacquer.
Upper Moulding—No. 3015 Croatan Green Lacquer.
Lower Moulding—No. 3015 Croatan Green Lacquer.

(Remove and Destroy Old Specifications)

PRESIDENT SEDAN

Big Six 127 inch W. B. (ES-W)

Above Moulding—No. 690 Black Lacquer.

Below Moulding—No. 3015 Croatan Green Lacquer.

Between Mouldings—No. 3015 Croatan Green Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

PRESIDENT SEDAN

Big Six 127 inch W. B. (ES-W, ES-Y)

Above Moulding—No. 690 Black Lacquer.

Below Moulding—No. 690 Black Lacquer.

Between Mouldings—No. 690 Black Lacquer.

Upper Moulding—No. 2963 Thistle Green Lacquer.

Lower Moulding—No. 2963 Thistle Green Lacquer.

PRESIDENT SEDAN

Big Six 127 inch W. B. (ES-K1)

Above Moulding—No. 428 Tulsa Gray Lacquer.

Below Moulding—No. 288 Arizona Brown Lacquer.

Between Mouldings—No. 288 Arizona Brown Lacquer.

Upper Moulding—No. 428 Tulsa Gray Lacquer

Lower Moulding—No. 428 Tulsa Gray Lacquer.

PRESIDENT SEDAN

Big Six 127 Inch W. B. (ES-K-2)

Above Moulding—No. 294 Modoc Brown Lacquer.

Below Moulding—No. 290 Hopi Drab Lacquer.

Between Mouldings—No. 290 Hopi Drab Lacquer.

Upper Moulding—No. 294 Modoc Brown Lacquer.

Lower Moulding—No. 294 Modoc Brown Lacquer.

DUPLEX TOURER (7 Pass.)
Big Six 127 inch W. B. (ES-T)

Body—No. 1568 Maxine Blue Lacquer.

Moulding—Black Lacquer.

DUPLEX TOURER (7 Pass.)
Big Six 127 inch W. B. (ES-T)

Below Moulding—No. 6019 Cree Blue Lacquer.

Between Mouldings—No. 6018 Manawa Blue Lacquer.

Upper Moulding—Black Lacquer.

Lower Moulding—Black Lacquer.

FOLDING TOP TOURER (7 Pass.)
Big Six 127 inch W. B. (ES-T)

Below Moulding—No. 291 Chico Drab Lacquer.

Between Mouldings—No. 290 Hopi Drab Lacquer.

Upper Moulding—Black Lacquer.

Lower Moulding—No. 290 Hopi Drab Lacquer.

(Remove and Destroy Old Specifications)

COMMANDER REGAL SEDAN
(EW-W2)

Above Moulding—No. 231 Yakima Brown Lacquer.
Below Moulding—No. 227 Kansas Brown Lacquer.
Between Mouldings—No. 227 Kansas Brown Lacquer.
Upper Moulding—No. 231 Yakima Brown Lacquer.
Lower Moulding—No. 231 Yakima Brown Lacquer.

COMMANDER REGAL SEDAN
(EW-W4)

Above Moulding—No. 4023 Tuchi Gray Lacquer.
Below Moulding—No. 3033 Bruce Green Light Lacquer.
Between Mouldings—No. 3033 Bruce Green Light Lacquer.
Upper Moulding—No. 4023 Tuchi Gray Lacquer.
Lower Moulding—No. 4023 Tuchi Gray Lacquer.

COMMANDER REGAL SEDAN
(EW-W5)

Above Moulding—No. 4 Limousine Blue Lacquer.
Below Moulding—No. 617 Pewamo Blue Lacquer.
Between Mouldings—No. 617 Pewamo Blue Lacquer.
Upper Moulding—No. 4 Limousine Blue Lacquer.
Lower Moulding—No. 4 Limousine Blue Lacquer.

COMMANDER REGAL SEDAN
(GB-W1)

Above Moulding—No. 578 Burgundy Lacquer.
Below Moulding—No. 578 Burgundy Lacquer.
Belt Panel—No. 4049 Deauville Sand Lacquer.
Upper Moulding—No. 578 Burgundy Lacquer.
Lower Moulding—No. 578 Burgundy Lacquer.

COMMANDER REGAL SEDAN
(GB-W2)

Above Moulding—No. 428 Suede Grey Lacquer.
Below Moulding—No. 288 Antelope Tan Lacquer.
Belt Panel—No. 288 Antelope Tan Lacquer.
Upper Moulding—No. 1625 Pecan Brown Lacquer.
Lower Moulding—No. 1625 Pecan Brown Lacquer.

COMMANDER REGAL SEDAN
(GB-W2)

Above Moulding—No. 3015 Hemlock Green Lacquer.
Below Moulding—No. 3024 Spirea Green Lacquer.
Belt Panel—No. 120 Old Ivory Lacquer.
Upper Moulding—No. 3015 Hemlock Green Lacquer.
Lower Moulding—No. 3015 Hemlock Green Lacquer.

CUSTOM SEDAN

Big Six 120 Inch W. B. (ES-S)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 4023 Tuchi Gray Lacquer.
Between Mouldings—No. 3016 Kinik Green Lacquer.

Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

COMMANDER SEDAN

(EW-W)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 4023 Tuchi Gray Lacquer.
Between Mouldings—No. 3016 Kinik Green Lacquer.

Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

COMMANDER SEDAN

(EW-W)

Above Moulding—No. 3022 Erskine Blue Green Lacquer.
Below Moulding—No. 3023 Erskine Green Light Lacquer.
Between Mouldings—No. 3023 Erskine Green Light, Lacquer.

Upper Moulding—No. 3022 Erskine Blue Green Lacquer.
Lower Moulding—No. 3022 Erskine Blue Green Lacquer.

COMMANDER SEDAN

(EW-W3)

Above Moulding—No. 3015 Croatan Green Lacquer.
Below Moulding—No. 3015 Croatan Green Lacquer.
Between Mouldings—No. 3015 Croatan Green Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.
Lower Moulding—No. 3015 Croatan Green Lacquer.

COMMANDER REGAL SEDAN

(EW-W1)

Above Moulding—No. 569 Nopal Maroon, Deep, Lacquer.
Below Moulding—No. 569 Nopal Maroon, Deep, Lacquer.
Between Mouldings—No. 569 Nopal Maroon, Deep, Lacquer.

Lower Moulding—No. 569 Nopal Maroon, Deep, Lacquer.
Upper Moulding—No. 569 Nopal Maroon, Deep, Lacquer.

(Remove and Destroy Old Specifications)

CUSTOM VICTORIA
Big Six 120 inch W. B. (ES-C)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 3015 Croatan Green Lacquer.
Between Mouldings—No. 3015 Croatan Green Lacquer.
Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

COMMANDER VICTORIA
(EW-C)

Above Moulding—No. 428 Tulsa Gray Lacquer.
Below Moulding—No. 288 Arizona Brown Lacquer.
Between Mouldings—No. 288 Arizona Brown Lacquer.
Upper Moulding—No. 428 Tulsa Gray Lacquer.
Lower Moulding—No. 428 Tulsa Gray Lacquer.

COMMANDER VICTORIA
(EW-C)

Above Moulding—No. 623 Waukegan Blue Lacquer.
Below Moulding—No. 6006 Hydrox Blue Lacquer.
Between Mouldings—No. 6006 Hydrox Blue Lacquer.
Upper Moulding—No. 623 Waukegan Blue Lacquer.
Lower Moulding—No. 6006 Hydrox Blue Lacquer.

COMMANDER REGAL VICTORIA
(EW-C1)

Above Moulding—No. 428 Tulsa Gray Lacquer.
Below Moulding—No. 288 Arizona Brown Lacquer.
Between Mouldings—No. 288 Arizona Brown Lacquer.
Upper Moulding—No. 428 Tulsa Gray Lacquer.
Lower Moulding—No. 428 Tulsa Gray Lacquer.

COMMANDER REGAL VICTORIA
(EW-C2)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 567 Soudan Light Maroon Lacquer.
Between Mouldings—No. 567 Soudan Light Maroon Lacquer.
Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

COMMANDER REGAL VICTORIA

(GB-C1)

Above Moulding—No. 578 Burgundy Lacquer.

Below Moulding—No. 578 Burgundy Lacquer.

Belt Panel—No. 4049 Deauville Sand Lacquer.

Upper Moulding—No. 578 Burgundy Lacquer.

Lower Moulding—No. 578 Burgundy Lacquer.

COMMANDER REGAL VICTORIA

(GB-C2)

Above Moulding—No. 428 Suede Gray Lacquer.

Below Moulding—No. 428 Suede Gray Lacquer.

Belt Panel—No. 288 Antelope Tan Lacquer.

Upper Moulding—No. 1625 Pecan Brown Lacquer.

Lower Moulding—No. 1625 Pecan Brown Lacquer.

COMMANDER REGAL VICTORIA

(GB-C2)

Above Moulding—No. 428 Suede Gray Lacquer.

Below Moulding—No. 288 Antelope Tan Lacquer.

Belt Panel—No. 288 Antelope Tan Lacquer.

Upper Moulding—No. 1625 Pecan Brown Lacquer.

Lower Moulding—No. 1625 Pecan Brown Lacquer.

COMMANDER REGAL VICTORIA

(GB-C3)

Above Moulding—No. 3015 Croatan Green Lacquer.

Below Moulding—No. 3015 Croatan Green Lacquer.

Between Mouldings—No. 3015 Croatan Green Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.

Lower Moulding—No. 3015 Croatan Green Lacquer.

(Remove and Destroy Old Specifications)

COMMANDER COUPE (2 Pass.)
(EW-Q)

Above Moulding—No. 3015 Croatan Green Lacquer.

Below Moulding—No. 3015 Croatan Green Lacquer.

Between Mouldings—No. 3015 Croatan Green Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.

Lower Moulding—No. 3015 Croatan Green Lacquer.

COMMANDER COUPE (4 Pass.)
(EW-E)

Above Moulding—No. 3015 Croatan Green Lacquer.

Below Moulding—No. 3024 Elton Green Lacquer.

Between Mouldings—No. 3024 Elton Green Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.

Lower Moulding—No. 3024 Elton Green Lacquer.

COMMANDER REGAL COUPE (4 Pass.)
(EW-E)

Above Moulding—No. 3015 Croatan Green Lacquer.

Below Moulding—No. 3024 Elton Green Lacquer.

Between Mouldings—No. 3024 Elton Green Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.

Lower Moulding—No. 3024 Elton Green Lacquer.

COMMANDER SPORT ROADSTER

(EW-J)

Above Moulding—No. 3024 Elton Green Lacquer.

Below Moulding—No. 3024 Elton Green Lacquer.

Between Mouldings—No. 3024 Elton Green Lacquer.

Lower Moulding—No. 1743 V. E. P. Coach Green Lacquer. Matched by Glidden's No. 3032 Coach Green Lacquer.

Upper Moulding—No. 1743 V. E. P. Coach Green Lacquer. Matched by Glidden's No. 3032 Coach Green Lacquer.

(Remove and Destroy Old Specifications)

DICTATOR CUSTOM SEDAN
(EU-W)

Above Moulding—No. 690 Black Lacquer.

Below Moulding—No. 617 Pewamo Blue Lacquer.

Between Mouldings—No. 652 Limousine Blue Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

DICTATOR CUSTOM SEDAN
(EU-W)

Above Moulding—No. 690 Black Lacquer.

Below Moulding—No. 6006 Hydrox Blue Lacquer.

Between Mouldings—No. 623 Waukegan Blue Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

DICTATOR CUSTOM SEDAN
(EU-W)

Above Moulding—No. 3015 Croatan Green Lacquer.

Below Moulding—No. 290 Hopi Drab Lacquer.

Between Mouldings—No. 290 Hopi Drab Lacquer.

Upper Moulding—No. 3015 Croatan Green Lacquer.

Lower Moulding—No. 3015 Croatan Green Lacquer.

DICTATOR SEDAN
(EU-W3)

Above Moulding—No. 623 Waukegan Blue Lacquer.

Below Moulding—No. 623 Waukegan Blue Lacquer.

Between Mouldings—No. 623 Waukegan Blue Lacquer.

Upper Moulding—No. 623 Waukegan Blue Lacquer.

Lower Moulding—No. 623 Waukegan Blue Lacquer.

DICTATOR SEDAN
(EU-W1)

Above Moulding—No. 6025 Light Blue Lacquer.

Below Moulding—No. 6025 Light Blue Lacquer.

Between Mouldings—No. 6025 Light Blue Lacquer.

Upper Mouldnig—No. 6025 Light Blue Lacquer.

Lower Moulding—No. 6025 Light Blue Lacquer.

DICTATOR SEDAN
(EU-W2)

Above Moulding—No. 294 Modoc Brown Lacquer.

Below Moulding—No. 290 Hopi Drab Lacquer.

Between Mouldings—No. 290 Hopi Drab Lacquer.

Upper Moulding—No. 294 Modoc Brown Lacquer.

Lower Moulding—No. 294 Modoc Brown Lacquer.

DICTATOR SEDAN
(EU-W3)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 4023 Tuchi Gray Lacquer.
Between Mouldings—No. 3016 Kinik Green Lacquer.
Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

DICTATOR ROYAL SEDAN
(GE-W1)

Above Moulding—No. 4 Limousine Blue Lacquer.
Below Moulding—No. 617 Pewamo Blue Lacquer.
Between Mouldings—No. 617 Pewamo Blue Lacquer.
Upper Moulding—No. 4 Limousine Blue Lacquer.
Lower Moulding—No. 4 Limousine Blue Lacquer.

DICTATOR ROYAL SEDAN
(GE-W2)

Above Moulding—No. 294 Sable Lacquer.
Below Moulding—No. 290 Fawn Lacquer.
Belt Panel—No. 290 Fawn Lacquer.
Upper Moulding—No. 294 Sable Lacquer.
Lower Moulding—No. 294 Sable Lacquer.

DICTATOR ROYAL SEDAN
(GE-W2)

Above Moulding—No. 290 Fawn Lacquer.
Below Moulding—No. 290 Fawn Lacquer.
Belt Panel—No. 294 Sable Lacquer.
Upper Moulding—No. 290 Fawn Lacquer.
Lower Moulding—No. 290 Fawn Lacquer.

DICTATOR ROYAL SEDAN
(GE-W2)

Above Moulding—No. 294 Sable Lacquer.
Below Moulding—No. 290 Fawn Lacquer.
Belt Moulding—No. 290 Fawn Lacquer.
Upper Moulding—No. 294 Sable Lacquer.
Lower Moulding—No. 294 Sable Lacquer.

DICTATOR ROYAL SEDAN
(GE-W3)

Above Moulding—No. 3019 Mesa Green Lacquer.
Below Moulding—No. 4024 Plati Gray Lacquer.
Belt Panel—No. 4024 Plati Gray Lacquer.
Upper Moulding—No. 3019 Messa Green Lacquer.
Lower Moulding—No. 3019 Mesa Green Lacquer.

(Remove and Destroy Old Specifications)

DICTATOR CUSTOM VICTORIA
(EU-C)

Above Moulding—No. 690 Black Lacquer.
Below Moulding—No. 4023 Tuchi Gray Lacquer.
Between Mouldings—No. 3016 Kinik Green Lacquer.
Upper Moulding—No. 690 Black Lacquer.
Lower Moulding—No. 690 Black Lacquer.

DICTATOR CUSTOM VICTORIA
(EU-C)

Above Moulding—No. 3015 Croatan Green Lacquer.
Below Moulding—No. 290 Hopi Drab Lacquer.
Between Mouldings—No. 290 Hopi Drab Lacquer.
Upper Moulding—No. 3015 Croatan Green Lacquer.
Lower Moulding—No. 3015 Crotan Green Lacquer.

DICTATOR VICTORIA
(EU-C1)

Above Moulding—No. 3019 Mesa Green Lacquer.
Below Moulding—No. 4024 Plati Gray Lacquer.
Between Mouldings—No. 4024 Plati Gray Lacquer.
Upper Moulding—No. 3019 Mesa Green Lacquer.
Lower Moulding—No. 4024 Plati Gray Lacquer.

DICTATOR VICTORIA
(EU-C2)

Above Moulding—No. 623 Waukegan Blue Lacquer.
Below Moulding—No. 623 Waukegan Blue Lacquer.
Between Mouldings—No. 623 Waukegan Blue Lacquer.
Upper Moulding—No. 623 Waukegan Blue Lacquer.
Lower Moulding—No. 623 Waukegan Blue Lacquer.

DICTATOR VICTORIA
(EU-C3)

Above Moulding—No. 6025 Light Blue Lacquer.
Below Moulding—No. 6025 Light Blue Lacquer.
Between Mouldings—No. 6025 Light Blue Lacquer.
Upper Moulding—No. 6025 Light Blue Lacquer.
Lower Moulding—No. 6025 Light Blue Lacquer.

DICTATOR ROYAL VICTORIA
(GE-C2)

Above Moulding—No. 290 Fawn Lacquer.
Below Moulding—No. 290 Fawn Lacquer.
Belt Panel—No. 294 Sable Lacquer.
Upper Moulding—No. 290 Fawn Lacquer.
Lower Moulding—No. 290 Fawn Lacquer.

DICTATOR ROYAL VICTORIA
(GE-C2)

Above Moulding—No. 4 Limousine Blue Lacquer.
Below Moulding—No. 6006 Hydrox Blue Lacquer.
Between Mouldings—No. 6006 Hydrox Blue Lacquer.
Upper Moulding—No. 4 Limousine Blue Lacquer.
Lower Moulding—No. 4 Limousine Blue Lacquer.

DICTATOR COUPE (2-Pass.)
(EU-Q)

Above Moulding—No. 623 Waukegan Blue Lacquer.
Below Moulding—No. 623 Waukegan Blue Lacquer.
Between Mouldings—No. 623 Waukegan Blue Lacquer.
Upper Moulding—No. 623 Waukegan Blue Lacquer.
Lower Moulding—No. 623 Waukegan Blue Lacquer.

DICTATOR COUPE (2-Pass.)
(EU-Q)

Above Moulding—No. 6025 Light Blue Lacquer.
Below Moulding—No. 6025 Light Blue Lacquer.
Between Mouldings—No. 6025 Light Blue Lacquer.
Upper Moulding—No. 6025 Light Blue Lacquer.
Lower Moulding—No. 6025 Light Blue Lacquer.

DICTATOR REGULAR BUSINESS COUPE
(GE-Q1)

Above Moulding—No. 4 Limousine Blue Lacquer.
Below Moulding—No. 4 Limousine Blue Lacquer.
Between Mouldings—No. 4 Limousine Blue Lacquer.
Upper Moulding—No. 4 Limousine Blue Lacquer.
Lower Moulding—No. 4 Limousine Blue Lacquer.

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(Remove and Destroy Old Specifications)
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DICTATOR SPORT COUPE (4-Pass.)

(EU-E)

Above Moulding—No. 3019 Mesa Green Lacquer.
Below Moulding—No. 4024 Plati Gray Lacquer.
Between Mouldings—No. 4024 Plati Gray Lacquer.
Upper Moulding—No. 3019 Mesa Green Lacquer.
Lower Moulding—No. 4024 Plati Gray Lacquer.

DICTATOR ROYAL CUSTOM COUPE

(GE-Q2)

Above Moulding—No. 3019 Spruce Green Lacquer.
Below Moulding—No. 4024 Dove Gray Lacquer.
Belt Panel—No. 4024 Dove Gray Lacquer.
Upper Moulding—No. 3019 Spruce Green Lacquer.
Lower Moulding—No. 3019 Spruce Green Lacquer.

DUPLEX TOURER
Standard Six (EU-T)

Body—Belgian Blue Lacquer.

Moulding—Black Lacquer.

DUPLEX TOURER
Standard Six (EU-T)

Below Moulding—No. 291 Chico Drab Lacquer.
Between Mouldings—No. 290 Hopi Drab Lacquer.

Upper Moulding—Black Lacquer.
Lower Moulding—No. 290 Hopi Drab Lacquer.

CUSTOM TOURER (5-Pass.)
Standard Six (EU-T)

Below Moulding—No. 293 Newago Brown Lacquer.
Between Mouldings—No. 292 Niwana Brown Lacquer.

Upper Moulding—Black Lacquer.
Lower Moulding—No. 292 Niwana Brown Lacquer.

CUSTOM TOURER (7-Pass.)
Standard Six (EU-L)

Below Moulding—No. 6019 Cree Blue Lacquer.
Between Mouldings—No. 6018 Manawa Blue Lacquer.

Upper Moulding—Black Lacquer.
Lower Moulding—No. 6018 Manawa Blue Lacquer.

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DICTATOR SPORT ROADSTER
(EU-J)

Below Moulding—No. 677 Chapa Blue Lacquer.

Between Mouldings—No. 676 Bola Blue Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

DICTATOR SPORT ROADSTER
(EU-J)

Below Moulding—No. 6023 Genesee Blue Lacquer.

Between Moulding—No. 6022 Itaska Blue Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

DICTATOR DUPLEX ROADSTER
(EU-R)

Below Moulding—No. 1009 Belgian Blue Lacquer.

Between Mouldings—No. 1009 Belgian Blue Lacquer.

Upper Moulding—No. 690 Black Lacquer.

Lower Moulding—No. 690 Black Lacquer.

May 1, 1928
(Remove and Destroy Old Specifications)

ERSKINE SIX SEDAN
(50-W)

Roof, Side Quarter and Rear Panel—No. 4047 Alcona Gray Lacquer.
Belt Moulding—No. 4047 Alcona Gray Lacquer.
Lower Body and Window Frames—No. 289 Maumee Brown Lacquer.

ERSKINE SIX SEDAN
(50-W)

Roof, Lower Body, Side Quarter and Rear Panel—No. 4046 Manola Gray Lacquer.
Belt Moulding—No. 4046 Manola Gray Lacquer.
Window Frames—No. 4045 Panoka Gray Lacquer.

ERSKINE SIX SEDAN
(50-W)

Roof, Side Quarter and Rear Panel—Match for Ditzler's Argonne Green Lacquer or Glidden's No. 3015 Croatan Green Lacquer.
Belt Moulding—Match for Ditzler's Argonne Green Lacquer or Glidden's No. 3015 Croatan Green Lacquer.
Lower Body and Window Frames—Ditzler's Pigskin Brown, Light Lacquer. Match for Glidden's No. 298 Pigskin Brown Light Lacquer.

ERSKINE SIX SEDAN
(50-W)

Roof, Side Quarter and Rear Panel—No. 3022 Erskine Blue Green Lacquer.
Belt Moulding—No. 3022 Erskine Blue Green Lacquer.
Lower Body and Window Frames—No. 3023 Erskine Green Light Lacquer.

ERSKINE SIX SEDAN
(50-W)

Roof, Side Quarter and Rear Panel—No. 3015 Croatan Green Lacquer.
Belt Moulding—No. 3025 Makinak Green Lacquer.
Lower Body and Window Frames—No. 3015 Croatan Green Lacquer.

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ERSKINE SIX SEDAN (DELUXE)
(51-W2)

Rear Panels, Window Reveals and Body Below Belt—No. 428 Suede Gray Lacquer.

Belt Moulding—No. 294 Sable Lacquer.

ERSKINE SIX SEDAN (DELUXE)
(51-W2)

Rear Panels, Window Reveals and Body Below Belt—No. 428 Suede Gray Lacquer.

Belt Moulding—No. 2002 Cocoanut Lacquer.

ERSKINE SIX SEDAN (REGULAR)
(51-W3)

Rear Panel, Window Reveals and Body Below Belt—No. 6031 Duskblu Lacquer.

Belt Moulding—No. 6032 Tapestry Blue Lacquer.

ERSKINE SIX CLUB SEDAN
(51-F)

Body Below Moulding and Window Reveals—No. 290 Fawn Lacquer.

Rear Panel and Belt Moulding—No. 294 Sable Lacquer.

ERSKINE SIX COUPE (2-Pass.)

(O-05)

Roof, Side Quarter and Rear Panel—No. 623 Waukegan Blue Lacquer.
Belt Moulding—Ditzler's Blue Devil Blue Lacquer matched by Glidden's No. 6020 Waupaka Blue Lacquer.
Lower Body and Window Frames—No. 623 Waukegan Blue Lacquer.

ERSKINE SIX SPORT COUPE (4-Pass.)

(50-E)

Roof, Side Quarter and Rear Panel—No. 4046 Manola Gray Lacquer.
Belt Moulding—Ditzler's Blue Devil Blue Lacquer matched by Glidden's No. 6020 Waupaka Blue Lacquer.
Lower Body and Window Frames—No. 623 Waukegan Blue Lacquer.

ERSKINE SIX SPORT COUPE (4-Pass.)

(50-E)

Roof, Side Quarter and Rear Panel—No. 3015 Croatan Green Lacquer.
Belt Moulding—No. 3025 Makinak Green Lacquer.
Lower Body and Window Frames—No. 3015 Croatan Green Lacquer.

ERSKINE SIX SPORT COUPE (4-Pass.)

(50-E)

Roof, Side Quarter and Rear Panel—No. 4045 Panoka Gray Lacquer.
Belt Moulding—Ditzler's Blue Devil Blue Lacquer matched by Glidden's No. 6020 Waupaka Blue Lacquer.
Lower Body and Window Frames—No. 4045 Panoka Gray Lacquer.

May 1, 1928
(Remove and Destroy Old Specifications)
PRINTED IN U. S. A.

ERSKINE SIX TOURER
(50-T)

Belt Moulding—Ditzler's Shalimar Brown Lacquer. Matched by Glidden's No. 297 Shalimar Brown Lacquer.

Body—Ditzler's Tusk Ivory Lacquer. Matched by Glidden's No. 154 Tusk Ivory Lacquer.

ERSKINE SIX TOURER
(50-T)

Belt Moulding—No. 4047 Alcona Gray Lacquer.

Body—No. 289 Maumee Brown Lacquer.

ERSKINE SIX SPORT ROADSTER
(50-J)

Belt Moulding—Valentine's Columbia River Obsidian Green Lacquer. Matched by Glidden's No. 3036 Ithica Green Lacquer.

Body—Valentine's Columbia River Obsidian Blue Lacquer. Matched by Glidden's No. 6027 Keota Blue Lacquer.

ERSKINE SIX BUSINESS & SPORT ROADSTER
(50-R-J)

Body except Raised Portion of Shroud and Moulding—No. 288 Arizona Brown Lacquer.

Raised Portion of Shroud and Moulding—No. 534 Manitou Red Lacquer.

Volume Three

BIG SIX, SPECIAL SIX AND BUS CHASSIS

Engine
Gasoline System

Unless otherwise specified the information herein given applies to all cars after Big Six serial number 2,060,001, Special Six serial number 3,120,001 and Bus Chassis serial numbers 2,070,600 and 3,173,001

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DIAGNOSIS

The following pages of diagnosis will be found of material value in tracing the sources of difficulty. The main headings have been taken directly from indications of trouble, such as "Engine Starts Hard" or "Engine Misses At Low Speed, Idling." Under these have been listed the causes for such conditions. Even the most experienced mechanic will find that such a list will often serve to jog his memory on causes which are infrequently encountered. Sections on "Test" and "Remedy" then follow except in a few cases where these items are so apparent as to need no explanation. In case more detailed information on any subject is required the General Information Section starting on page 37 or the Operation Articles starting on page 111 should be consulted.

ENGINE

Engine Will Not Start

Cause

1. Ignition switch off.
2. No gasoline.
3. Ice in carburetor float chamber.
4. Choke not properly adjusted.
5. Carburetor passages stopped up.
6. Throttle improperly used or connections loose.
7. Cylinders flooded with gasoline.
8. Water on ignition coil or high tension terminals.
9. Spark plugs dirty or points improperly adjusted.
10. Distributor breaker points sticking, dirty or improperly adjusted.
11. Ignition out of time.
12. Loose battery connections or battery discharged.
13. Engine oil congealed at low atmospheric temperature, resulting from:
    - Use of too heavy oil in cold weather.
    - Sludge formation in oil pan.
14. Coil to distributor secondary wire grounded.
15. Distributor rotor grounded.
16. Broken or disconnected wire in primary circuit.
17. Bad air leak in intake manifold or carburetor gaskets, resulting from:
    - Crack in intake manifold.
    - Loose manifold nuts.
    - Broken or damaged intake manifold or carburetor gaskets.
18. Valves improperly timed.
19. Broken cam gear.
20. Poor compression, resulting from:
    - Cylinder head nuts loose.
    - Priming cocks or spark plugs loose in head or damaged.
    - Valves holding open due to stem being warped or corroded.
    - Valves holding open due to lack of push rod clearance.
    - Weak valve springs.
    - Cylinder head gasket broken or damaged.
    - Carbon on valve seat.
    - Weak or broken piston rings.
21. Muffler or exhaust pipe clogged.

Test

2 and 3. See that there is gasoline in the rear tank.

Remove the carburetor float needle cap and lift up the needle. If the carburetor does not flood, remove the float chamber cover. If no gasoline is found in the float chamber, disconnect the vacuum tank to carburetor feed pipe at the carburetor. A good flow of gasoline from this pipe would indicate dirt in the carburetor screen or ice in the bottom of the carburetor float chamber. If no gasoline flows from the vacuum tank to carburetor feed pipe, disconnect the pipe at the vacuum tank. If gasoline flows from the vacuum tank, then the feed pipe must be obstructed with dirt. If the car is equipped with a gasoline filter and the glass bowl is filled with gasoline, this would indicate a free flow from the vacuum tank. An accumulation of dirt, sufficient to obstruct the flow of gasoline will be visible in the glass bowl. If no gasoline flows from the vacuum tank this would indicate a defective tank mechanism or dirt in the tank. See vacuum tank instructions, page 33.

4. To test the choke valve adjustment on the Stromberg carburetor, open the regulating sleeve and observe the position of the valve. This should be closed tight when the choke button on the instrument board is pulled out. When the choke button is pushed clear in the valve should be wide open or horizontal. On Stromberg carburetors equipped with air cleaners, the choke valve is wide open when the slot in the end of the choke valve shaft is horizontal.

On Ball and Ball carburetors it is necessary to remove the air pipe from the air intake horn to observe the position of the choke valve.

5. With the choke pulled out and the ignition switch off, turn the engine several revolutions with the starter or crank. This should flood the carburetor, causing a small amount of gasoline to flow from the hole at the bottom of the air intake horn. If the carburetor cannot be flooded in this manner it may be taken as an indication that some of the passages are clogged.

6. Move the throttle lever on the steering wheel up and observe the throttle butterfly shaft at the carburetor. If the shaft does not move with the movement of the throttle lever, look for a broken or disconnected control rod. Also see that the rocker arm at the lower end of the throttle tube moves with the throttle lever. See Remedy for proper use of throttle lever.

7. Open the priming cups and turn the engine over with the starter or crank.

The cylinder flooded will be indicated by a spray of gasoline from the priming cups.

8. Examine the top of the coil and the high tension terminals on the distributor and spark plugs, for water or dampness.

9. Remove the spark plugs. Check the gap between the points with a .025 of an inch thickness gauge. Examine the plug for carbon on the porcelain and inside of the plug shell.

10. Remove the distributor cap and rotor. When turning the engine slowly with the crank the breaker point should open and close with each cam peak. If the points do not close, refer to "Remedy", item 10.

Examine the breaker points. The contact points are in good condition when they have a clean frosted surface.

Turn the engine with the crank until the contact points open. Check the gap with a .020 of an inch thickness gauge.

11. To check the ignition timing see No. 2 Test under "Popping in Muffler," page 25.

12. If the starter will not crank the engine, examine the two battery cable connections, battery ground connection and the connections at the starter switch to see if they are loose.

Loose connections at the battery may be indicated by badly corroded terminals. Also when pressing the starter switch the lights will dim or go out and a cracking noise or slight sparking will sometimes occur at the point where the connection is loose.

Test the battery with a hydrometer. If the hydrometer reading shows 1.225 or more the difficulty is not in the battery.

13. Drain a sample of oil from the engine. The oil should flow freely. If too heavy a grade of oil is used in cold weather it will congeal and offer excessive resistance to cranking the engine.

14. See if the coil to distributor secondary wire is touching the engine. Remove this wire and examine for thin insulation or insulation worn off.

15. To test the distributor rotor for a ground refer to Vol. 7.

16. To make a primary circuit wiring test, refer to Vol. 7.

17. Examine the intake manifold for a crack. Examine the carburetor and intake manifold gaskets. Leaks may be indicated by broken or damaged gaskets.

18. Valves will not be found out of time unless something is broken or the cam and crankshaft gears are improperly meshed. To check the valve timing, see Operating Article No. 25.

19. Remove the valve cover plate. Turn the engine with the crank. No valve action may indicate a broken cam gear.

20. The engine compression should be tested with a compression gauge. (See C. O. 64, Vol. 8). If no gauge is available, crank the engine slowly. Weak or no compression will be indicated by very little or no resistance to cranking the engine at the compression stroke of each cylinder. If this test shows compression to be weak, proceed as follows:

Check the cylinder head nuts, priming cups and spark plugs to see that they are tight and in good condition.

Remove the valve cover plates. Have someone turn the engine with the crank and observe the valve action. If any of the valves rise and do not follow the push rods down, but come down very slowly or not at all, this would indicate sticking valve stems.

Valve spring tension should also be tested by stretching the springs with a screw driver while the engine is being cranked. Springs when removed from the engine should show a pressure of 45 to 50 pounds when compressed to 1 13/16 of an inch.

If the valve action is found to be correct, check the push rod clearance. This should be not less than .008 of an inch with the engine cold.

If the difficulty has not been located after making the above tests, remove the cylinder head and examine the gasket. A broken or damaged gasket may cause compression leaks.

If the cylinder head gasket is found to be in good condition, remove the valves from the engine.

If a valve is not seating properly it will be indicated by the condition of the valve face or seat which will show signs of carbon deposit or corrosion, due to burning gases passing between the valve face and the seat.

If the valves are found to be functioning properly, it will then be necessary to remove the oil pan, pull the pistons and examine the rings.

Weak rings will allow compression to blow by the piston into the crankcase. This can often times be heard through the breather opening.

Rings should require a weight of 8 to 11 pounds on the Big Six or 7 to 10 pounds on the Special Six to just close the gap.

Broken rings will bring about the same condition as weak rings and in addition possibly cause a ring slap and scored cylinders.

Rings fitted to the cylinders with too wide a gap will give same results as weak rings. The gap should be from .012 to .022 of an inch. See page 42.

Rings loose in the piston groove will allow compression to escape back of the ring. See page 42.

Rings binding in the groove will not conform to the cylinder and therefore bring about the same condition as weak or broken rings.

Examine the cylinder walls for score.

21. Try to start the engine with the muffler removed from the car. If it starts easily without the muffler disassemble and examine the muffler for carbon.

Remedy

2 and 3. Remove the strainer screen at the lower part of the float chamber. Clean all dirt from the screen. If the screen is broken install a new one. Clean the inside of the float chamber and the vacuum tank to carburetor feed pipe. If necessary, remove the glass bowl and screen at the filter and clean thoroughly.

If the difficulty is found to be in the vacuum tank, see vacuum tank instruction page 33.

4. If the valve is not properly adjusted, push the choke button clear in, then loosen the set screw holding the wire and move the valve to its wide open position. Tighten the set screw in this position. Check the adjustment as described under "Test," item 4.

5. Remove and clean the primary jet on Ball and Ball carburetor or the gasoline reducer on the Stromberg. If this does not correct the difficulty refer to Operation Articles No. 51, 52 or 53.

6. To start the Special Six engine, open the throttle slightly by means of the lever on the steering wheel.

To start the Big Six engine the throttle must be in the *closed* position, unless the car is equipped with the Model SV-33 Ball and Ball carburetor. In this case, open the throttle about one-fourth the way from the closed position.

7. To blow out the cylinders when flooded with gasoline open the priming cups and spin the engine rapidly with the crank or starter for several revolutions with the throttle closed.

8. Water on the high tension wires or top of the coil may be quickly dried by using an air hose or tire pump. Apply the air to the top of the distributor and coil and the ends of the wires.

9. To clean a spark plug, disassemble it and wipe off all carbon from the porcelain with a rag moistened with gasoline. Never scrape or sand the porcelain as this will cause carbon to deposit more rapidly and also weaken the insulating qualities of the porcelain. Scrape out the inside of the plug shell, clean the points and reassemble, making sure that the two copper asbestos gaskets are in good condition and in place. Set the point gap at .025 of an inch using a thickness gauge to space them.

10. Remove the breaker arm from the distributor. If the spring is broken install a new one. Make sure that the arm works freely on the pin. If it does not, use a small piece of fine sand paper on the pin and apply a drop of oil before installing the breaker arm.

If the points are found to be slightly pitted they may be cleaned by filing them with a contact point file until the surfaces are flat and smooth. A good surface can also be obtained by removing the points and stoning them on a medium hard stone. This way is more accurate and is preferable to filing.

If the points are badly pitted new ones should be installed. Adjust the gap between the points, when fully open, to .020 of an inch.

11. For instructions on ignition timing, see Operation Article No. 18, operation 10.

12. The battery connections should be kept clean and tight. Loose connections will soon result in badly corroded terminals. Disconnect the cables from the battery. Clean all corrosion from the battery terminals and cable connections. Before connecting the cables, apply vaseline to the battery terminals. This will help to prevent corrosion. Tighten the battery cable ground connection if necessary.

If the battery is found to be discharged, it must be removed from the car and recharged.

13. In case of congealed oil or sludge formation, the oil pan should be removed and the inside of the engine crankcase and oil pan should be washed out with gasoline. Refill with clean oil of the proper grade. A medium oil should be used in warm weather and a light cold test oil in cold weather.

14. If the coil to distributor secondary wire is damaged or has the insulation worn off, install a new wire.

15. For information on a grounded distributor rotor, refer to Vol. 7.

16. A broken wire may be spliced and taped. However, the best repair is to install a new wire.

17. In case of a cracked manifold a new one should be installed. This part can very seldom be satisfactorily welded.

Loose intake manifold or carburetor nuts may also cause air leaks. See that these are tight. If the gaskets are damaged install new ones.

18. If the valves are found to be out of time, this means that the cam gear must be removed and meshed properly with the crank gear. See Operation Article No. 22.

19. If the cam gear is broken a new one must be installed. See Operation Article No. 22 to remove and replace the cam gear.

20. Tighten all loose cylinder head nuts, priming cups or spark plugs. If the spark plugs or priming cups are damaged install new ones.

If the valves are holding open due to lack of push rod clearance, adjust the push rods to .008 of an inch. After the engine is started and warmed up readjust them if necessary to .005 of an inch. On all bus engines the tappetts should be adjusted to not less than .008 inch with the engine warm.

If the valve stems are warped install new valves. Corroded valve stems may be cleaned in gasoline

and polished with fine emery paper. Clean all carbon from the top of the cylinder block and valve seat. Grind the valve before assembling. See Operation Article No. 4.

In case of weak valve springs install new ones.

If the cylinder head gasket is damaged install a new one.

If the piston rings are weak, broken or too wide a gap, install new rings.

21. Disassemble and clean the muffler thoroughly. Before assembling the muffler to the exhaust pipe tap the pipe with a hammer. This will loosen the accumulation of carbon in the pipe. Start the engine and accelerate to blow the carbon from the pipe.

Engine Starts Hard

Cause

1. Carburetor mixture too lean or too rich. (Stromberg).
2. Carburetor choke mechanism improperly adjusted.
3. Distributor breaker points sticking, dirty or improperly adjusted.
4. Spark plug points improperly adjusted.
5. Battery connections loose or battery weak.
6. Weak coil.
7. Gasoline level too low in carburetor float chamber, due to:
   Improper float needle valve adjustment.
8. Air leak in intake manifold gaskets, resulting from:
   Crack in intake manifold.
   Loose manifold nuts.
   Broken or damaged intake manifold or carburetor gaskets.
9. Poor compression, resulting from:
   Cylinder head nuts loose.
   Priming cups or spark plugs loose in head or damaged.
   Valves holding open due to stems being warped or corroded.
   Valves holding open due to lack of push rod clearance.
   Weak valve springs.
   Cylinder head gasket broken or damaged.
   Carbon on valve seat.
   Weak or broken piston rings.
10. Muffler or exhaust pipe clogged.

Test

1. Screw the carburetor high speed adjustment down (clockwise) until completely closed, then back off 5 turns. Screw the idling adjustment in (clockwise) until completely closed and back off 1¼ turns.

This adjustment applies only to the Stromberg carburetor on the Special Six and if the difficulty is with the carburetor adjustment it will bring it near enough to the correct setting to permit starting the engine.

2. To test the choke valve adjustment on the Stromberg Carburetor, open the regulating sleeve and observe the position of the valve. This should be closed tight when the choke button on the instrument board is pulled out. When the choke button is pushed clear in the valve should be wide open or horizontal. On Stromberg carburetors equipped with air cleaners, the choke valve is wide open when the slot in the end of the choke valve shaft is horizontal.

On Ball and Ball carburetors it is necessary to remove the air pipe from the air intake horn to observe the position of the choke valve.

3. Remove the distributor cap and rotor. When turning the engine slowly with the crank the breaker points should open and close with each cam peak. If the points do not close, refer to "Remedy," Item 3.

Examine the breaker points. The contact points are in good condition when they have a clean frosted surface.

Turn the engine with a crank until the contact points open. Check the gap with a .020 of an inch thickness gauge.

4. Test the spark plug electrodes with a thickness gauge. The gap should be .025 inch.

5. If the starter will not crank the engine, examine the two battery cable connections, the battery ground connection and the connections at the starter switch to see if they are loose.

Loose connections at the battery may be indicated by badly corroded terminals. Also when pressing the starter switch the lights will dim or go out and a cracking noise or slight sparking will occur at the point where the connection is loose.

Test the battery with a hydrometer. If the hydrometer reading shows 1.225 or more the difficulty is not in the battery.

6. To test the ignition coil refer to Vol. 7.

7. Remove the carburetor needle valve cap and lift up the needle valve, allowing the carburetor to flood for a moment. Then attempt to start the engine. If the engine starts readily check the needle valve adjustment as described on pages 49 and 51.

8. To locate air leaks in the intake manifold, cover the intake manifold joints with gasoline squirted from an oil can while the engine is running. The gasoline will be drawn in at the leaky joint and will usually cause a difference in the running of the engine.

Test all intake manifold bolts with a wrench to see if they are tight and examine the manifold for crack.

9. A complete test for poor compression is given under "Engine Will Not Start," item 20, page 8.

10. Try to start the engine with the muffler removed from the car. If it starts easily without the muffler disassemble and examine the muffler for carbon.

Remedy

1. The carburetor adjustment should be correctly made as described on page 50, after the engine is warmed up.

2. If the valve is not properly adjusted, push the choke button clear in, then loosen the set screw holding the wire and move the valve to its wide open position. Tighten the screw in this position. Check the adjustment as described under "Test", item 2.

3. Remove the breaker arm from the distributor. If the spring is broken install a new one. Make sure that the arm works freely on the pin. If it does not, use a small piece of fine sand paper on the pin and apply a drop of oil before installing the breaker arm.

If the points are found to be slightly pitted they may be repaired by filing them with a contact point file until the surfaces are flat and smooth. A good surface can also be obtained by removing the points and stoning them on a medium hard stone. This way is more accurate and is preferable to filing.

If the points are badly pitted new ones should be installed. Adjust the gap between the points, when fully open to .020 of an inch.

4. Adjust the spark plug electrodes with a thickness gauge. The gap should be .025 inch.

5. The battery connections should be kept clean and tight. Loose connections will soon result in badly corroded terminals. Disconnect the cables from the battery. Clean all corrosion from the battery terminals and cable connection. Before connecting the cables, apply vaseline to the battery terminals. This will help to prevent corrosion. Tighten the battery cable ground connection if necessary.

If the hydrometer shows a reading lower than 1.225 it is advisable to remove the battery from the car and recharge it.

6. If the coil is weak it must be replaced.

7. For carburetor float adjustment, see pages 49 and 51.

8. In case of a cracked manifold a new one should be installed. This part can very seldom be satisfactorily welded.

Loose intake manifold or carburetor nuts may also cause air leaks. See that these are tight. If the gaskets are damaged install new ones.

9. For poor compression see "Remedy," item No. 20 under "Engine Will Not Start."

10. Disassemble and clean the muffler thoroughly. Before assembling the muffler to the exhaust pipe tap the pipe with a hammer. This will loosen the accumulation of carbon in the pipe. Start the engine and accelerator to blow the carbon from the pipe.

Engine Misses at All Speeds

Cause

1. Spark plugs dirty, porcelains cracked or points improperly spaced.
2. Carburetor improperly adjusted (Stromberg).
3. Distributor breaker points sticking, dirty or improperly adjusted.
4. Carburetor choke mechanism not properly adjusted.
5. Vacuum tank flooding.
6. Short circuit in distributor to spark plug wires.
7. Loose or corroded connections in ignition circuit.
8. Distributor cover cracked.
9. Defective condenser or condenser terminals loose or corroded.
10. Poor compression, resulting from:
    - Cylinder head nuts loose.
    - Priming cups or spark plugs loose in head or damaged.
    - Valves holding open due to stems being warped or corroded.
    - Valves holding open due to lack of push rod clearance.
    - Weak valve springs.
    - Cylinder head gasket broken or damaged.
    - Carbon on valve seat.
    - Weak or broken piston rings.

Test

1. Remove the spark plugs from the engine and examine them for cracked or broken porcelains. They should be disassembled and carefully cleaned for inspection if necessary.

Check the gap between the points with a .025 of an inch thickness gauge.

2. The average setting on the high speed needle is from 2½ to 3¼ turns and on the low speed needle, 1¼ to 1½ turns. If the setting is within this range, the difficulty is probably not with the carburetor adjustment.

3. Remove the distributor cap and rotor. When turning the engine slowly with the crank the

breaker points should open and close with each cam peak. If the points do not close refer to "Remedy," item 3.

Examine the breaker points. The contact points are in good condition when they have a clean frosted surface.

Turn the engine with the crank until the contact points open. Check the gap with a .020 of an inch thickness gauge.

4. To check the choke valve adjustment on the Stromberg carburetor, open the regulating sleeve and observe the position of the valve, this should be closed tight when the choke button on the intrument board is pulled out, and wide open or horizontal when the choke button is pushed in. On Stromberg carburetors equipped with air cleaners, the choke valve is wide open when the slot in the end of the choke valve shaft is horizontal.

On Ball and Ball carburetors it is necessary to remove the air pipe from the air intake horn to observe the position of the choke valve.

5. See page 33 for vacuum tank information.

6. Short circuited spark plug wires can sometimes be located while the engine is running. A spark will jump where the short occurs. If the short circuit is inside of the fiber tube it will be necessary to remove the wires and examine them for damaged insulation.

7. Inspect all connections from ammeter to distributor, to check for loose connection or corroded terminal (high resistance). See Vol. 7.

8. Remove distributor cover and examine for cracks.

9. Examine the condenser for loose or corroded terminals, particularly for corrosion on the grounded side, where moisture is liable to collect.

For condenser test refer to Vol. 7.

10. To make the test for poor compression, refer to "Engine Will Not Start," item 20, page 7.

Remedy

1. If the spark plug porcelains are found to be cracked or damaged new plugs must be installed.

To clean the plugs, disassemble them and wipe off all carbon from the porcelains with a rag moistened with gasoline. Never scrape or sand the porcelain as this will cause carbon to deposit more rapidly and also weaken the insulating qualities of the porcelain. Scrape out the inside of the plug shell, clean the points and reassemble making sure that the two copper asbestos gaskets are in good condition and in place.

Set the gap between the points to .025 of an inch, using a thickness gauge to space them.

2. To adjust the carburetor, follow instructions given on page 50.

3. Remove the breaker arm from the distributor. If the spring is broken install a new one. Make sure that the arm works freely on the pin. If it does not, use a small piece of fine sand paper on the pin and apply a drop of oil before installing the breaker arm.

If the points are found to be slightly pitted they may be repaired by filing them with a contact point file until the surfaces are flat and smooth. A good surface can also be obtained by removing the points and stoning them on a medium hard stone. If the points are badly pitted new ones should be installed.

Adjust the gap between the points when fully open to .020 of an inch.

4. If the valve is not properly adjusted, push the choke button clear in, then loosen the set screw holding the wire and move the valve to its wide open position. Tighten the set screw in this position. Check the adjustment as described under "Test", item 4.

5. See page 33 for vacuum tank information.

6. In case of shorted spark plug wires, new wires should be installed.

7. Clean and tighten all connections in ignition circuit.

8. If the distributor cover is found to be cracked, install a new one.

9. If the condenser is found to be defective install a new one. If not defective, clean all paint and rust from the terminal and ground contact before replacing.

10. For the remedy for poor compression see "Engine Will Not Start," item 20.

Engine Misses at High Speed

Cause

1. Carburetor improperly adjusted (Stromberg).
2. Choke not properly adjusted.
3. Carburetor, vacuum tank or gas lines clogged.
4. Spark plug points not properly adjusted.
5. Distributor breaker points sticking, dirty or improperly adjusted.
6. Valves holding open, resulting from:
   - Lack of push rod clearance.
   - Stems being warped or corroded.
   - Weak springs.
   - Carbon on valve seat.
7. Valves improperly timed.

Test

1. The average setting on the high speed needle is from 2½ to 3¼ turns. If the setting

is within this range, the difficulty is probably not with the carburetor adjustment.

2. To check the choke valve adjustment on the Stromberg carburetor, open the regulating sleeve and observe the position of the valve. This should be closed tight when the choke button on the instrument board is pulled out, and wide open or horizontal when the choke button is pushed in. In Stromberg carburetors equipped with air cleaners the choke valve is wide open when the slot in the end of the choke valve is horizontal.

On the Ball and Ball carburetor it is necessary to remove the air pipe from the air intake horn to observe the position of the choke valve.

3. Remove and inspect the strainer screen at the lower part of the carburetor float chamber.

Disconnect the vacuum tank to carburetor pipe and examine for dirt.

If no gasoline flows from the vacuum tank after this pipe has been removed, this would indicate that the vacuum tank is not functioning properly. See page 33. If the car is equipped with a gasoline filter, an accumulation of dirt, sufficient to obstruct the flow of gasoline will be visible in the glass bowl.

4. Check the spark plug points with a thickness gauge. The gap should be .025 of an inch.

5. Remove the distributor cap and rotor. When turning the engine slowly with a crank, the breaker points should open and close with each cam peak. If the points do not close, refer to "Remedy," item 5.

Examine the breaker points. They are in good condition when they have a clean, frosted surface.

Turn the engine with the crank until the contact points open. Check the gas with a .020 of an inch thickness gauge.

6. To test for sticking valves or valves holding open, refer to "Test," item No. 20, under "Engine Will Not Start." Page 8.

7. To check the valve timing, see Operation Article No. 25.

Remedy

1. To adjust the carburetor, see instructions starting on page 47.

2. If the choke is not properly adjusted, push the choke button clear in, then loosen the set screw holding the wire and move the valve to its wide open position. Tighten the set screw in this position. Check the adjustment as described under "Test," item 2.

3. Remove the strainer screen at the lower part of the float chamber. Clean all dirt from the screen. If the screen is damaged or broken install a new one. Clean the inside of the float chamber and the vacuum tank to carburetor pipe. If necessary, remove the glass bowl and screen at the filter and clean thoroughly.

If the difficulty is found to be in the vacuum tank not functioning, see the vacuum tank instructions on page 33.

4. Adjust the spark plug points with a thickness gauge. The gap should be .025 of an inch.

5. Remove the breaker arm from the distributor. If the spring is broken install a new one. Make sure that the arm works freely on the pin. If it does not, use a small piece of fine sand paper on the pin and apply a drop of oil before installing the breaker arm.

If the points are found to be slightly pitted they may be repaired by filing them with a contact point file until the surfaces are flat and smooth. A good surface can also be obtained by removing the points and stoning them on a medium hard stone. This way is more accurate and is preferable to filing. If the points are badly pitted new ones should be installed.

Adjust the gap between the points when fully open to .020 of an inch.

6. See "Engine Will Not Start," Remedy," item 20.

7. If the valves are improperly timed, the cam gear must be removed and properly meshed with the crankshaft gear. See Operation Article No. 22.

Engine Misses at Low Speed, Idling

Cause

1. Carburetor improperly adjusted (Stromberg).
2. Spark plug points too close together.
3. Spark too far advanced.
4. Air leak in intake manifold or gaskets, resulting from:
   - Crack in intake manifold.
   - Loose manifold nuts.
   - Broken or damaged intake manifold or carburetor gaskets.
5. Loose battery connections or battery weak.
6. Ignition coil defective.
7. Intake valve stems loose in guides.
8. Poor compression, resulting from:
   - Cylinder head nuts loose.
   - Priming cups or spark plugs loose in head or damaged.
   - Valves holding open due to stems being warped or corroded.
   - Valves holding open due to lack of push rod clearance.
   - Weak valve springs.
   - Cylinder head gasket broken or damaged.
   - Carbon on valve seat.
   - Weak or broken piston rings.

Test

1. The average setting on the high speed needle is from 2½ to 3¼ turns and on the low speed needle from 1¼ to 1½ turns. If the setting is within this range, the difficulty is probably not with the carburetor adjustment.

2. Check the spark plug gaps with a .025 of an inch thickness gauge.

3. Check the ignition timing, see No. 2 "Test" under "Popping in Muffler," page 25.

4. To locate air leaks in the intake manifold, cover the intake manifold joints with gasoline squirted from an oil can while the engine is running. The gasoline will be drawn in at the leaky joint and will usually cause a difference in the running of the engine.

Test all the intake manifold bolts with a wrench to see if they are tight and examine the manifold for a crack.

5. If the starter cranks the engine very slowly or not at all, examine the two battery cable connections and the battery ground connection to see if they are loose.

Loose connections at the battery may be indicated by badly corroded terminals. Also when pressing the starter switch, a cracking noise or slight sparking will sometimes occur where a connection is loose.

Test the battery with a hydrometer. If the hydrometer reading shows 1.225 or more the difficulty is not in the battery.

6. To test the ignition coil refer to Vol. 7.

7. If the intake valve stems are badly worn the engine will miss at low speed, due to the additional air which is drawn in through the valve guides. This will cause a very lean idling mixture and should be easily located as it will be necessary to adjust the carburetor so rich to make the engine idle that it will not operate properly at high speed.

The excessive play also will cause the valves to be very noisy.

8. See "Engine Will Not Start," "Test," item No. 20.

Remedy

1. See carburetor adjustment starting on page 47.

2. Adjust the spark plug point gaps with a .025 of an inch thickness gauge.

3. To set the ignition timing, see Operation Article 18, operation 10.

4. In case of a cracked manifold a new one must be installed. This part can very seldom be satisfactorily welded. See that the manifold nuts are tight. If the gaskets are damaged install new ones.

5. The battery connections should be kept clean and tight. Loose connections will soon result in badly corroded terminals. Disconnect the cables from the battery. Clean all corrosion from the battery terminals and cable connectors. Before connecting the cables, apply vaseline to the battery terminals. This will help to prevent corrosion. Tighten the battery cable ground connection if necessary.

If the battery is found to be low, it must be removed from the car and recharged.

6. See Vol. 7.

7. If the valve stems are found to be badly worn, new valves and guides must be installed.

8. See "Engine Will Not Start," "Remedy," item No. 20.

Engine Misses at Low Speed on Pull

Cause

1. Spark plug points too far apart.
2. Battery connections loose or battery weak.
3. Air leak in intake manifold or gaskets, resulting from:
   - Crack in intake manifold.
   - Loose manifold nuts.
   - Broken or damaged gaskets.
4. Poor compression, resulting from:
   - Cylinder head nuts loose.
   - Priming cups or spark plugs loose in head or damaged.
   - Valves holding open due to stems being warped or corroded.
   - Valves holding open due to lack of push rod clearance.
   - Weak valve springs.
   - Cylinder head gasket broken or damaged.
   - Carbon on valve seat.
   - Weak or broken piston rings.
5. Ignition coil defective.
6. Muffler or exhaust pipe clogged.

Test

1. Check the spark plug point gap with a .025 of an inch thickness gauge.

2. If the starter cranks the engine very slowly or not at all, examine the two battery cable connections, the battery ground connection and the connections at the starter switch to see if they are loose.

Loose connections at the battery may be indicated by badly corroded terminals. Also when pressing the starter switch the lights will dim or go out and a cracking noise or slight sparking will sometimes occur at the point where the connection is loose.

Test the battery with a hydrometer. If the hydrometer reading shows 1.225 or more the difficulty is not in the battery.

3. To locate air leaks in the intake manifold, cover the intake manifold joints with gasoline squirted from an oil can while the engine is running. The gasoline will be drawn in at the leaky joint and will usually cause a difference in the running of the engine.

Test all the intake manifold bolts with a wrench to see if they are tight and examine the manifold for a crack.

4. See "Engine Will Not Start," "Test," item No. 20.

5. To test the ignition coil refer to Vol. 7.

6. Try to run the engine with the muffler removed from the car. If an improvement is noticed disassemble and examine the muffler for carbon.

Remedy

1. Adjust the spark plug gaps with a .025 of an inch thickness gauge.

2. The battery connections should be kept clean and tight. Loose connections will soon result in badly corroded terminals. Disconnect the cables from the battery. Clean all corrosion from the battery terminals and cable connectors. Before connecting the cables, apply vaseline to the battery terminals. This will help to prevent corrosion. Tighten the battery cable ground connection if necessary.

If the battery is found to be low, it must be removed from the car and recharged.

3. In case of a cracked manifold, a new one should be installed. This part can very seldom be satisfactorily welded.

Loose intake manifold or carburetor nuts may also cause air leaks. See that these are tight. If the gaskets are damaged install new ones.

4. See "Engine Will Not Start," "Remedy," item No. 20.

5. See Vol. 7.

6. Disassemble and clean the muffler thoroughly. Before assembling the muffler to the exhaust pipe tap the pipe with a hammer. This will loosen the accumulation of carbon in the pipe. Start the engine and accelerate to blow the carbon from the pipe.

Engine Knocks and Noises
Spark Knock

Cause

1. Carbon in cylinder.
2. Ignition timed too early.
3. Carburetor adjusted too lean.
4. Engine overheats.
5. Poor grade of gasoline.

Test

1. There is a natural accumulation of carbon in the cylinders of any internal combustion engine.

Excessive carbon in the cylinders will be indicated by detonation causing a sharp knock most noticeable when the engine is accelerated or is under load.

A carbon knock will only occur when the engine is hot.

The use of one of the anti-knock brands of gasoline now on the market will eliminate the carbon knocks and do away with the necessity of frequent carbon removal.

2. Too early ignition timing will cause a knock which may be mistaken for a carbon knock. The engine may also kick back when starting.

Check the ignition timing. See "Test," item 2, under "Popping in Muffler," page 25.

3. If the knock is caused by a lean mixture it will disappear on pulling the choke button out a short way. This is not conclusive however, as choking the engine will also deaden a carbon knock to some extent. Examine the carburetor high speed needle to see if it is from 2½ to 3¼ turns open. This is the average adjustment and if the setting is near the maximum, the difficulty is not with the carburetor adjustment.

4. See No. 4 Test under "Loss of Power."

5. A poor grade of gasoline may cause detonation resulting in a knock or "ping" usually recognized as a carbon knock.

Remedy

1. To clean the carbon deposit from the cylinders it is necessary to remove the head. Scrape all carbon from the top of the cylinder block, pistons and inside of the cylinder head.

2. Set the ignition timing as instructed in Operation Article No. 18, operation 10.

3. See instructions on carburetor adjustment starting on page 47.

4. See No. 4 Remedy under "Loss of Power."

5. The use of a good grade of gasoline is the remedy in this case.

Crank Shaft Knocks

Cause

1. Crankshaft loose in bearings, resulting from:

Worn or burned bearings.
Sprung crankshaft, or crankshaft journals out of round.

2. Bearing shells loose in crankcase, resulting from:

Bearing set screws loose and clearance between edges of upper and lower bearing shells.

3. End play in crankshaft.

Test

1. Loose main bearings may be indicated by a heavy, dull knock, more noticeable on rapid acceleration of the engine or when the engine is laboring. Main bearing knocks can as a rule, be located by shorting out the cylinder on either side of bearing which is loose, thereby muffling the sound.

Examine the bearings to see if they show signs of being burned, or are burned out.

A sprung crankshaft will make it impossible to take up the main bearings uniformly and will cause the bearings to loosen up rapidly after being taken up. If the crankshaft is removed from the engine, test it with Surface Indicator, C.O. 63. See Vol. 8.

Test the crankshaft journals for being out of round with a micrometer. See Vol. 8.

2. Bearing shells loose in the case will be indicated by a knock very similar to a main bearing knock. By removing the bearing cap an examination can be made which will usually determine whether the shell is loose. Also examine the edges of the bearings which should be just flush with the face of the cap and the face of the crankcase web.

3. Excessive end play in the crankshaft may cause an intermittent knock which will disappear when slight pressure is put on the clutch pedal. Too much end play might also cause an oil leak at the timing gear case due to the oil throw ring rubbing against the bronze ring on the gear case cover.

The end play may be accurately tested with the Surface Indicator Gauge C.O. 63 (See Vol. 8). Remove the oil pan, clamp the guage stand to the engine crankcase and place the gauge against a flat surface of the crankshaft. Pry the shaft as shown in Illus. No. 35, and the amount of end play, in thousandths of an inch, will be registered on the gauge.

If the C.O. 63 gauge is not available, the end play may be determined by measuring between the crankshaft and thrust bearing flanges with a thickness gauge, first prying the crankshaft as in Illus. No. 35.

If the clearance is more than .012 to .015 of an inch, see "Remedy," item 3.

Remedy

1. Loose main bearings may be tightened by removing the cap and dressing down the surface with a piece of medium emery cloth. Lay the emery cloth on a surface plate or piece of plate glass and rub the bearing cap over the cloth, being careful not to remove too much metal at a time. See Operation Article No. 35, for full instructions.

If the bearings are burned, install new ones. See Operation Article 39.

It is well to use the oil test cylinder (see C.O. 415, Vol. 8), while the crankshaft is removed from the engine. This will wash out the oil distributor pipe and holes in the crankcase webs and disclose any points which are stopped up.

If the crankshaft is sprung more than .004 of an inch it must be straightened. An arbor press is the most convenient means of doing this.

If the crankshaft journals are badly out of round it is advisable to install a new shaft.

2. If the engine has been run with the bearing shells loose in the cap and crankcase it is advisable to install new ones as the backs of the bearings will be worn so they will not fit properly in the cap and crankcase web.

To install new bearings see Operation Article No. 39.

3. More than .012 to .015 of an inch crankshaft end play is excessive and should be removed.

The correct amount with new bearings is .004 of an inch. Excessive end play in the crankshaft can be eliminated by installing a new thrust bearing cap. This however, is not the best procedure as all the thrust would then be carried by the cap only. A new upper shell (in the case) should also be installed.

Due to the added expense involved in installing a new upper shell (making it necessary to remove the engine from the car, etc.) the method to be used should be decided by the owner after the situation has been explained to him.

If the cap only is replaced, the owner should be advised to have a new upper shell installed the next time the engine is taken from the car for any other bearing work.

Piston and Connecting Rod Knocks

Cause

1. Connecting rod loose on crankshaft.
2. Piston pin loose in piston or rod, resulting from:

Worn bushing.
Clamp bolt loose.

3. Piston pin broken.
4. Piston loose in cylinder.
5. Piston ring broken.
6. Connecting rod out of alignment, resulting from:

Twisted or sprung rod.
Rod bearing improperly fitted.

Test

1. A loose connecting rod bearing will be indicated by a knock which will occur at crankshaft speed and can be shorted out. This knock is very noticeable upon accelerating the engine and suddenly closing the throttle. It can be distinguished from a main bearing knock as the sound is lighter and more metallic.

A loose connecting rod bearing knock is usually very pronounced when the engine is idling at high speed but disappears under a light load.

2. A loose piston pin may be indicated by a sharp metallic knock when the engine is idling slowly or pulling a light load, and can be shorted out. If the test indicates that the knock is in the piston pin, remove the oil pan and pull the piston. (See Operation Article No. 31). Examine the piston pin clamp bolt. A loose clamp bolt may have caused the knock.

3. A broken piston pin will be indicated by a very loud metallic knock. This may result in a broken piston and serious damage to the engine.

4. A piston excessively loose in the cylinder may cause a knock known as "piston slap" which is more noticeable when accelerating the engine under a pull and can be shorted out. It will also be more pronounced when the engine is cold.

The most accurate test for piston slap is to remove the spark plug from the offending cylinder and pour, through the spark plug hole, about ¼ pint of heavy steam engine oil. Replace the spark plug and run the engine. If the noise has momentarily disappeared, it would indicate piston slap.

There is no stated clearance at which it is necessary to change a piston as sometimes a slap is so slight as to be unnoticeable.

5. Broken piston rings will sometimes cause a sharp clicking noise which will occur at all engine speeds and cannot be shorted out. In this case it is advisable to remove the pistons and examine the rings.

6. A connecting rod out of alignment may cause a light metallic knock very similar to a piston slap. Remove the rods and pistons from the engine (see Operation Article No. 31) and examine the pistons. If the rod is out of alignment the piston will show wear at the top on one side and at the bottom on the other.

Examine the connecting rod bearing. This should have at least a 75 per cent bearing surface.

To check the rod for alignment, see Vol. 8.

Remedy

1. A connecting rod bearing loosened from normal wear may be taken up (see Operation Article No. 34).

A connecting rod bearing scorched or burned out would indicate lack of lubrication. This may be caused by the engine having been run with little or no oil in the oil pan, or the oil passageway to the rod may be clogged. In this case install a new connecting rod, see Operation Article No. 32.

Before putting in the new connecting rod the engine must be removed, the crankshaft taken out and all oil passageways thoroughly cleaned.

2. If the piston pins are loose in the bushings, install new pins and bushings. (see Operation Article No. 33), making sure that the pins are securely anchored in the connecting rods when reassembling and that the pins are not fitted too tight in the bushings. Pins fitted too tight will not allow the proper oil film between the pin and the bushing with consequent danger of burning and seizing.

3. A broken piston pin may necessitate the installation of a new piston as well as a new pin, depending upon the damage that has resulted. Install new parts where broken or damaged.

If it is found necessary to install a new piston see that it is fitted to the cylinder bore with a clearance of .0035 to .004 of an inch for the Special Six and .004 to .0045 of an inch for the Big Six. The feeler stock C.O. 66 (see Vol. 8) can be used to gauge the clearance.

To install a new piston pin follow carefully Article No. 33.

4. In case of a piston slap due to piston and cylinder bore being badly worn it will be necessary to install a new piston.

In this case, however, the cylinder should be refinished before the piston is installed as it will be worn out of round. Use the cylinder test indicator (see Vol. 8) to determine the condition of the cylinder.

Tools which may be used to refinish the cylinders are described in Vol. 8.

See Piston Clearance on page 42 for detailed instructions on fitting the pistons.

In every case where rapid wear has indicated lack of lubrication, a test should be made with the oil test cylinder as given in previous paragraphs.

5. If the piston rings are broken, install new ones.

Fit the rings into the cylinder bore and check the gap between the ends (Illus. No. 39). For plain and oil seal rings the gap should be .012 to .022 of an inch. For Perfect Circle rings it should be .010 to .015 of an inch on the Big Six and .007 to .012 of an inch on the Special Six. If the gap is less than the minimum given the ends of the rings should be filed (see C.O. 209, Vol. 8).

Examine the cylinder bore. A broken ring may have caused a scored cylinder. In this case it will be necessary to rebore or hone the cylinder. See Vol. 8.

6. Remove the rod and piston from the engine and disassemble them. Straighten the rod with the connecting rod aligning fixture described under C.O. 68, Vol. 8.

In case of a poor connecting rod bearing follow instructions in Operation Article No. 32.

Camshaft Knocks

Cause

1. Camshaft loose in front bearing.
2. Front bearing loose in case.
3. End play in camshaft, resulting from:
   Worn thrust washer.
   Cam gear not pressed on far enough.
   Gear loose on shaft.
4. Burrs on timing gear teeth.
5. Cam gear teeth broken.

Test

1. Camshaft knocks may be distinguished from other bearing knocks by the fact that they occur at half engine speed and can sometimes be muffled by prying on the water pump shaft.

It is advisable to remove the gear case cover and test the play by prying up on the gear. If badly worn see "Remedy," item 1.

2. Inspect the camshaft front bearing set screw. If loose or broken see "Remedy," item 2.

3. Excessive end play may cause a knock occurring at half engine speed. It can sometimes be muffled by prying on the water pump shaft.

It is advisable to remove the front gear case cover to examine the camshaft for end play. Also examine the cam gear to see that it is tight on the shaft. This should be a press fit.

4. Burrs on the gear teeth may cause a gear knock. If the teeth are damaged, see "Remedy," item 4.

5. Cam gear teeth chipped or broken will cause the gears to be noisy. Examine the cam gear.

Remedy

1. A camshaft loose in the front bearing can only be remedied by installation of a new bearing and thrust washer.

To install the new bearing and thrust washer see Operation Article No. 24, using new parts when assembling.

2. If the engine has been run very long with the front camshaft bearing loose it is advisable to install a new bearing and thrust washer as the bearing will be worn and cannot be tightened.

Follow instructions given in Item 1, "Remedy." Also install new set screw if necessary.

3. If the cam gear has been recently worked on, the end play may be due to the gear not being pressed on far enough. In this case it would only be necessary to press the gear into place using the cam gear installing fixture C.O. 423, (See Vol. 8).

If the end play is due to wear, install a new bearing and thrust washer. Follow instructions under "Remedy," item 1.

The cam gear should be a press fit on the camshaft.

If the gear is a loose fit on the shaft a new one should be installed. Install also a new camshaft key if necessary.

4. Small burrs on the gear teeth can be removed with an oil stone.

5. If the gear teeth are broken, install a new gear. See Operation Article No. 22.

Valve and Push Rod Knocks

Cause

1. Push rods improperly adjusted.
2. Push rod adjusting screw worn.
3. Push rod loose in guide.
4. Push rod guide loose in cylinder block, resulting from:
   Push rod guide clamp nut loose.
   Push rod guide clamp assembled up side down.
5. Valve stems loose in guide.
6. Valves holding open or weak or broken valve springs.
7. Cam or bottom face of push rod worn.

Test

1. Too much push rod clearance will be indicated by excessive tappet noise when the engine is running.

Remove the valve cover plates and check the clearance. With the engine warm this should be .005 of an inch on passenger cars and .008 on busses.

2. The push rod adjusting screws may become worn from long usage. In this case the valves cannot be properly adjusted, and will be noisy even though adjusted to the correct clearance.

Examine the push rod adjusting screw.

3. Unusual wear in the valve push rod guides will cause a "side slap" and excessive push rod noise which cannot be removed by adjustment.

It is not necessary to remove the push rod from the engine to test for a worn guide. With the engine running pull the push rod to one side. This should muffle or eliminate the knock.

Another test may be made. Turn the engine until the valve is down and the push rod is free to turn. With the push rod in this position it will be possible to feel the side play.

4. Test the push rod guide clamp nut with a wrench to see if it is loose, also see if the clamp is installed with the arch up.

5. Valve stems excessively loose in the guides will be indicated by the valves being noisy, regardless of correct push rod adjustment.

To test for loose valve stems, pull stem to one side while the engine is running. This should muffle or eliminate the noise.

Worn intake valve stems will also cause the engine to miss at idling speed.

6. See test under "Engine Will Not Start," item 20, page 8.

7. A valve push rod worn on the bottom face or a worn cam will be indicated by excessive tappet noise which cannot be silenced by adjustment.

In this case it is advisable to remove the push rod and guide, (See Operation Article No. 7), and examine the bottom of the push rod and the cam for wear.

Remedy

1. Clearance between the push rod adjusting screws and the valve stems should be adjusted to not less than .005 of an inch or greater than .008 of an inch on passenger cars with the engine warm. On bus engines the clearance must never be less than .008 of an inch. Check the clearance accurately with a thickness gauge.

Push rod adjustment should not be made with a view of gaining extreme quietness at this point, but to obtain the quietest possible adjustment with the correct minimum clearance.

2. If the push rod adjusting screws are worn, install new ones.

To remove and replace the push rods and guides see Operation Article No. 7.

3. If the push rods are loose in the guides it is advisable to install both the push rod and guide where necessary.

4. Tighten the push rod guide clamp nut. Make sure that the clamp is assembled with the arch up.

5. To remedy loose valve stems both the valve and the guide must be replaced. It is very seldom possible to obtain a satisfactory repair by installing oversize valves inasmuch as this will not remedy the worn guides.

6. In the case of valves holding open refer to "Remedy," under "Engine Will Not Start," item 20, page 9.

7. Excessive wear on the bottom face of the push rod will necessitate the installation of new ones. See Operation Article No. 7 to remove and replace.

It is very seldom that the cams will become worn enough to cause noise. However, if this ever does occur, a new camshaft will be necessary as it is impossible to repair it.

Water Pump Knocks

Cause

1. End play in impeller shaft.
2. Impeller broken or impeller pin sheared.

Test

1. Excessive end play in the impeller shaft may cause an intermittent metallic knock which can sometimes be temporarily stopped by tightening the packing nut.

Excessive end play may also cause a very loud squeak due to the impeller blades rubbing on the inside of the pump housing.

2. If the impeller is broken or the impeller pin sheared the water pump will not function. This usually occurs from attempting to crank the engine with the water in the pump frozen.

Remove the radiator cap and with the engine running at medium speed observe the circulation through the radiator filler pipe.

If water cannot be seen to circulate and the engine overheats it is evident that the pump is not working.

Remedy

1. To remove the end play, disassemble the water pump (see Operation Article No. 20), and reassemble using a new thrust washer and a new bushing in the gear case front cover. If the shaft is worn install a new one.

2. To install a new impeller or pin, see Operation Article No. 20, using new parts when assembling.

Miscellaneous Knocks

Cause

1. Engine loose in frame.
2. Flywheel loose on crankshaft.

Test

1. If the engine bolts are loose, a knock may be noticed when driving over rough roads with the engine laboring or when the engine is accelerated with the car not running. If the bolts are loose enough to permit a knock they usually can be turned with the fingers. If they cannot be thus turned, test them with a wrench.

2. A knock caused by a loose flywheel is most noticeable when accelerating and retarding the en-

gine, at the point of disengaging the clutch. This noise might be confused with a knock due to excessive end play in the crankshaft.

To determine whether or not the flywheel is loose, release the clutch and test with a pry bar through the inspection hole in the transmission bell housing.

Remedy

1. The crankcase to frame bolts should be inspected occasionally and tightened if found loose. Use heavy lock washers on these bolts.

2. If the flywheel is loose on the crankshaft, remove the transmission and clutch (see Operation Article No. 41, operation 1) and examine the bolts to see if they are cut due to the engine running with a loose flywheel. If the bolts are damaged install new ones. Tighten them securely making sure to insert cotter pins.

Timing Gear Noises

Cause

1. Gears meshed too tight, resulting from:
   Main bearings having been taken up when badly worn.
   Not maintaining proper gear centers when installing new main bearings.
2. Gears mesh too loose, resulting from:
   Gears worn.
   Not maintaing proper gear centers when installing new main bearings.
3. Burrs on gear teeth.
4. Gears not matched.
5. Cam gear teeth broken.

Test

1. Gears meshed too tight will be indicated by a hum. It is advisable to remove the front gear case cover and check the back lash in the gears. New gears should have approximately .003 of an inch back lash, although a satisfactory installation can be made with less. See "Remedy," item 1.

2. Gears meshed too loose will be indicated by a gear rattle in the front end of the engine. The rattle can sometimes be muffled by prying on the water pump shaft when the engine is running. Remove the front gear case cover and check the gear back lash.

3. Burrs on the gear teeth may cause a gear knock. If the teeth are damaged, see "Remedy," item 3.

4. If new timing gears have been installed in the engine with the proper amount of back lash and are found to be noisy, it may be due to the fact that the gears are not propertly matched. See "Remedy," item 4.

5. Cam gear teeth chipped or broken will cause the gears to be noisy. Examine the cam gear. The other gears are steel and will not be likely to chip.

Remedy

1. Gears slightly tight are not detrimental to the operation of the engine as the gears will wear to a bearing and the noise will disappear.

If an objectionable gear hum is due to worn main bearings having been adjusted, install new bearings.

An excessively loud gear hum after installing new main bearings might indicate that the bearings have not been reamed to a proper gear center and can sometimes be eliminated by trying several sets of gears.

Follow closely Operation Article No. 39 when installing new bearings.

2. In case of excessive back lash due to worn gears, install new gears.

If the gears are not worn and new main bearings have been installed in the engine, excessive back lash may be due to the bearings not having been reamed to proper gear centers. This can sometimes be remedied by trying several sets of gears.

3. Small burrs on the gear teeth can be removed with an oil stone.

4. Timing gears in service stock are not matched.

When installing new gears it may sometimes be necessary to try several sets before a set is found that will run quietly. Always install both the crankshaft and camshaft gear as it is impossible to make a quiet installation by using one new gear and one worn one.

5. If the gear teeth are broken, install new gears. See Operation Article No. 22 and 23 to remove and replace the gears.

Fan Noises

Cause

1. Fan bearings dry, broken or improperly adjusted.

Test

1. Remove the fan, disassemble and examine the bearings.

Remedy

1. Install new bearings and cones where damaged or worn.

If the ball bearings appear to be in good condition but feel rough when rotated, wash them thoroughly in gasoline, dry carefully and repack them with grease before replacing. Adjust the front cone on the fan spindle so that the fan spins freely without play in the bearings. This does not apply to fan with plain bearings.

Adjust the fan belt just tight enough so that it will drive the fan without slipping. Too tight an adjustment will cause additional wear on the bearings.

Starter Clutch Noisy

Cause

1. Lack of lubrication.
2. Broken housing ring.
3. Starter clutch bushing worn.

Test

1. Lack of lubrication may be indicated by excessive noise and sticking or slipping of the clutch when starting the engine due to the pawls being dry or gummed up with old oil.

2. A broken housing ring may cause a knock or noise in the starter clutch each time the break passes a pawl.

Remove the starter clutch from the engine, disassemble it and examine the ring.

3. Excessive play in the starter clutch sprocket may indicate a worn starter clutch bushing.

Remedy

1. In case of a dry and sticking or slipping starter clutch it will be necessary to remove it from the engine, disassemble it and wash all parts thoroughly with gasoline. If flat spots are worn on the starter clutch pawls, install new ones. When reassembling, lubricate the oiling felts thoroughly. Use nothing but engine oil.

2. If the starter clutch housing ring is broken install a new housing and ring complete.

3. In case of a worn starter clutch bushing, install a new bushing.

Generator Drive Noisy

Cause

1. Drive shaft or bushing worn.
2. End play in drive shaft, resulting from:
   Worn thrust bearings.
   Improper adjustment.
   Adjusting screw ball worn.
3. Generator coupling bumpers worn, jammed or missing.
4. Worn drive gear.

Test

1. A loose or worn generator drive shaft may cause a light knock which will occur at twice engine speed. The noise can usually be muffled by applying side pressure on the shaft when the engine is running. If necessary, remove the genertor and check the play by moving the shaft in the bushings.

2. End play in the generator drive shaft due to improper adjustment may be felt by lifting up and down on the shaft with the generator removed. End play due to a worn or broken thrust bearing may be indicated by a grinding noise which can be muffled by applying side pressure on the shaft.

Remove the generator, if necessary, to make sure the noise is not coming from this source and then check again by pressing on the shaft with the engine running.

3. A visual inspection of the generator coupling will usually determine whether the bumpers are worn, jammed or missing. If necessary remove the generator to inspect.

4. A worn drive shaft gear may be indicated by excessive back lash and a gear rattle. The rattle may be muffled by applying side pressure to shaft when the engine is running. See that the adjusting screw is properly adjusted to make sure that the noise is not coming from this source. See Operation Article No. 26.

Remove the generator if necessary and test the back lash in the shaft.

Remedy

1. If the generator drive shaft and bushings are found to be badly worn, install new parts. See Operation Article No. 26, to remove and replace.

2. End play in the generator drive shaft due to improper adjustment or ordinary wear on the thrust bearings can be remedied by making the proper setting at the adjusting screw. See Operation Article No. 26.

If the end play is due to an excessively worn or broken thrust bearing, or a worn adjusting screw ball, install new parts.

3. If the generator coupling rubber bumpers are worn, or missing, install new rubber bumpers. See Operation Article No. 17.

Jammed bumpers may be correctly assembled and used, if they have not been run long in this condition. If they are damaged, however, it will require new ones.

4. Excessive wear on the generator drive gear would necessitate the installation of a new gear. See Operation Article No. 26 to remove and replace.

Miscellaneous Noises

Cause

1. Muffler and exhaust pipe noisy, resulting from:
   Muffler shells loose.
   Muffler outlet pipe loose or missing.
   Exhaust pipe hitting cross member.

2. Fan hitting radiator or belt, resulting from:
   Bent fan blade.
   Bent fan support bracket.
   Improperly adjusted.
   Fan support loose on support stud. (Does not apply to self-adjusting type).
3. Dust pans rattle.
4. Horn rattles.

Test

1. Loose muffler shells will rattle when the engine is accelerated while running idle.

If the tail pipe is missing the exhaust will be slightly louder.

Inspect the hook which holds the exhaust pipe to the frame cross member (on the left hand side of the transmission) to see if the nut is loose or if the hook is missing. If this hook is loose it will allow the exhaust pipe to strike the cross member.

2. Raise the hood and with the engine running, watch the fan. The belt riding the pulley flange may indicate a bent fan support bracket or the bracket too far forward on the support stud. Inspect the fan for bent blades.

If the fan has come loose and damaged the radiator refer to "Remedy," item 2, to eliminate the cause of this difficulty.

3. Examine the dust pans to see if they are damaged, or if the bolts are loose.

4. If the horn is loose on the horn bracket it may cause a vibration more noticeable when the engine is accelerated or when the car is driven on a rough road. Examine the horn fastening bolts and nuts.

Remedy

1. If the muffler shells are loose they may be tightened by drawing up the stay bolt nuts at each end of the muffler. In case the shells are damaged or broken a new muffler must be installed.

If the muffler outlet pipe is broken or damaged, install a new pipe making sure to fasten it securely.

Tighten the exhaust pipe hook nut. If the hook is missing, install a new one.

2. If the fan support bracket is bent, install a new bracket and adjust the fan. See Operation Article No. 10 to remove and replace.

Bent fan blades can be straightened. If the blades are cracked or broken install a new fan.

If trouble has been experienced with the fan support bracket coming loose on the stud, proceed as follows:

The fan arm should be perfectly tight on the stud. Next, adjusting screw "B" (Illus. No. 15), should rest firmly on bracket "G." If a lock washer has not been installed under lock nut "E" this can be done as an additional factor of safety and the nut drawn up as tight as possible.

After the adjustment is made, gap "A" in the fan support should be examined. If for any reason this gap has closed before the support is tight on the stud, the fan may, of course, work off. If this condition exists remove the fan support bracket from the stud and widen the gap so as to permit the support to clamp on the stud securely. The gap can be widened by sawing out a small amount with a hack saw.

3. If the dust pans are broken or damaged, install new ones. See that all pan bolts are securely tightened with lock washers in place.

4. Tighten the horn fastening bolts.

Loss of Power

Cause

1. Weak spark, resulting from:
   - Spark plug points improperly adjusted.
   - Distributor contact points burned, dirty or improperly adjusted.
   - Loose battery connections or battery weak.
   - Defective coil.
2. Brakes dragging.
3. Poor compression, resulting from:
   - Loose cylinder head nuts.
   - Priming cups or spark plugs loose in head or damaged.
   - Valves holding open due to stems being warped or corroded.
   - Valves holding open due to lack of push rod clearance.
   - Weak valve springs.
   - Cylinder head gasket broken or damaged.
   - Carbon on valve seat.
   - Weak or broken piston rings.
   - Scored cylinder.
4. Engine overheats, resulting from:
   - Lack of water in cooling system.
   - Carburetor improperly adjusted.
   - Fan belt slipping or broken.
   - Ignition timed late.
   - Carbon in cylinders.
   - Water pump inoperative.
   - Cooling system clogged.
   - Valves improperly timed.
5. Stiff engine, resulting from:
   - Tight pistons or rings.
   - Lack of lubrication.
6. Muffler or exhaust pipe clogged.

Test

1. Check the spark plug gaps with a .025 of an inch thickness gauge.

Remove the distributor cap and rotor and examine the contact points. The contact points are in good condition when they have a clean frosted surface. Turn the engine with the crank until the breaker arm fiber bumper is on the lobe of the cam. Check the gap between the points with a .020 of an inch thickness gauge.

If the starter cranks the engine very slowly or not at all, examine the two battery cable connections and the battery ground connection to see if they are loose.

Loose connections at the battery may be indicated by badly corroded terminals. Also when pressing the starter switch, a cracking noise or slight sparking will sometimes occur where a connection is loose.

Test the battery with a hydrometer. If the hydrometer reading shows 1.225 or more the difficulty is not in the battery.

To test the coil, see Vol. 7.

2. Dragging brakes may be indicated by the brake drums becoming hot. Raise the car with a jack and see if the wheels turn hard. Check the brake adjustment with a .015 of an inch thickness gauge. The gauge should pass between the band and the drum at any point. See Vol 2.

3. To test for poor compression, refer to "Engine Will Not Start," Test No. 20.

4. If the engine overheats make the following tests:

See that the radiator is filled with water.

Check the carburetor adjustment. The average setting on the high speed needle is from 2½ to 3¼ turns and on the low speed needle, 1¼ to 1½ turns. If the setting is within this range, the difficulty is probably not with the carburetor adjustment.

Check the fan belt adjustment. This should be set so that it will just drive the fan without slipping. Also see that the belt is applied with the smooth side to the pulley.

Check the ignition timing. (See No. 2 Test under "Popping in Muffler").

Check the engine for carbon. Excessive carbon in the cylinders will be indicated by detonation causing a sharp knock most noticeable when the engine is accelerated or is under a load. A carbon knock will only occur when the engine is hot.

Remove the radiator cap and with the engine running at medium speed observe the circulation through the radiator filler pipe. If the water pump is not functioning or the cooling system is clogged the top of the radiator will become excessively hot while the lower part is still cool. At low atmospheric temperature this might also indicate a frozen radiator or ice in the cooling system.

In case of no water circulation it will be necessary to remove and inspect the upper and lower radiator hose, for obstructions. Have the radiator tested for clogged tubes by an experienced radiator man. Disassemble and examine the water pump for a broken impeller, sheared impeller pin and key or broken shaft.

Check the valve timing. (See Operation Article No. 25).

5. In case of the engine becoming tight it is advisable to examine the oil in the oil pan. This should be between the "half" and the "full" mark on the oil level indicator.

If the quantity of oil is correct and the dash gauge does not register, disconnect the pressure gauge pipe from the oil pump pipe. Start the engine and run it slowly. If oil does not flow from the pump pipe, the oil pump is not functioning or

has lost its prime. Prime the pump through the pump pipe and again start the engine to see if the pump is working. If the pump does not throw out the prime the difficulty is in the pump and further tests will not be necessary.

If the pump operates after being primed, examine for the following causes:

Air leaks at pump body or cover gaskets.
Suction pipe loose, cracked or obstructed.
Oil too heavy or congealed.

If the engine is stiff due to new pistons or rings having been installed refer to "Remedy," item 5.

6. Try the car on a pull with the muffler removed to see if this makes a difference in the power.

Remedy

1. If the spark plug points are badly burned it is advisable to install new plugs. Adjust the gap between the points to .025 of an inch.

If the distributor breaker points are found to be slightly pitted they may be repaired by filing them with a contact point file until the surfaces are flat and smooth. A good surface can also be obtained by removing the points and stoning them on a medium hard stone. This way is more accurate and is preferable to filing. If the points are badly pitted new ones should be installed. Adjust the gap between the points, when fully open, to .020 of an inch.

The battery connections should be kept clean and tight. Loose connections will soon result in badly corroded terminals. Disconnect the cables from the battery. Clean all corrosion from the battery terminals and cable connectors. Before connecting the cables, apply vaseline to the battery terminals. This will help to prevent corrosion. Tighten the battery cable ground connection if necessary.

If the hydrometer shows a reading lower than 1.225 it is advisable to remove the battery from the car and recharge it. A weak battery, however, will only affect the ignition spark at low speed as the ignition current is furnished by the generator when the engine is operating at high speed. However, the battery must be extremely weak in order to affect the ignition.

If the coil is weak install a new one.

2. Adjust the brakes. See Operation Article No. 38, Vol. 2.

3. See "Engine Will Not Start," Item 20 under "Remedy."

4. Adjust the carburetor as instructed on page 47.

If the fan belt is broken install a new one. See Operation Article No. 10 to adjust the belt.

Adjust the ignition timing, (See Operation Article No. 18, operation 10).

To clean the carbon deposit from the cylinders, it is necessary to remove the cylinder head. Scrape all carbon from the top of the cylinder block, pistons and inside of the cylinder head. Carefully polish all surfaces of the combustion chamber with a brush as this will retard the accumulation of carbon.

If the water pump is inoperative install new parts where broken or damaged. To disassemble the pump, see Operation Article No. 19 and 20.

If the radiator hose are clogged install new hose.

Clogged radiator tubes should be repaired only by an experienced radiator man.

If the valves are found to be out of time it will be necessary to remove the front and upper gear case covers, pull off the cam gear and reassemble so that the tooth marked "O" on the crankshaft gear meshes between the two teeth marked "O" on the cam gear. See Operation Article No. 22 to remove and replace the cam gear.

5. If the trouble is found to be an inoperative oil pump, remove and disassemble the pump. Install new gears if worn or broken. When reassembling, install new gaskets. *Important*—See that the oil pump cover gasket is not more than .007 of an inch in thickness and do not apply shellac at this point.

If the oil suction pipe is clogged, remove the pipe and clean it thoroughly, making sure the gland nut is tightened securely when reassembling.

In case of a cracked suction pipe, install a new pipe.

If the engine oil is congealed or too heavy, wash the inside of the engine crankcase and oil pan with gasoline. Use new oil when reassembling. A medium oil should be used in warm weather and a light, *cold test* oil in cold weather.

Running the engine will, of course, remedy any tightness due to new pistons or rings having been installed.

6. Disassemble and clean the muffler thoroughly. Before assembling the muffler to the exhaust pipe tap the pipe with a hammer. This will loosen the accumulation of carbon in the pipe. Start the engine and accelerate to blow the carbon from the pipe.

Backfiring in Carburetor

Cause

1. Cold engine.
2. Carburetor adjusted too lean.
3. Air leak in intake manifold, resulting from:
   Broken or damaged gaskets.
   Loose manifold nuts.
   Crack in manifold.
4. Dirt in gasoline line.

5. Intake valves not seating, resulting from:
   Lack of push rod clearance.
   Stems warped or corroded.
   Weak valve springs.
6. Late spark timing.
7. Secondary cables not connected according to firing order.

Test

1. An improperly operated choke button may cause the engine to backfire when cold. Test by applying the remedy for this item.

2. See No. 2 "Test" under "Engine Misses at All Speeds," page 11.

3. Air leaks may be indicated by the engine not idling properly or missing at low speed.

To locate an air leak in the intake manifold, have the engine running at the speed where the missing is most noticeable and cover the manifold joints with gasoline squirted from an oil can. The gasoline will be drawn in at the leaky joint and will usually cause a difference in the running of the engine. Examine the intake manifold for cracks.

4. To test for dirt in the gasoline line, remove the carburetor float chamber cover. Dirt in the feed pipe or carburetor screen may be indicated by a very slow flow of gasoline into the carburetor, or entire failure to flow. Examine the inside of the float chamber for dirt. Remove and examine the inlet screen at the lower part of the float chamber.

Disconnect the vacuum tank to carburetor feed pipe at the carburetor. Very slow or no flow of gasoline from this pipe may indicate dirt in the pipe.

To test for dirt in the vacuum tank or an inoperative tank, disconnect the vacuum tank to carburetor feed pipe. Very slow or no flow of gasoline from the vacuum tank would indicate trouble in the vacuum tank or rear tank line, see "Gasoline Will Not Flow From Vacuum Tank," page 34.

5. To check the intake valves for poor seating, see Test No. 20 under "Engine Will Not Start."

6. and 7. See No. 2 "Test" under "Popping in Muffler."

Remedy

1. To start the engine when cold the choke button on the dash should be pulled all the way out. As soon as the engine starts, push the choke button about one-third of the way or to the point where the engine runs smoothly. This should eliminate backfiring while the engine is warming up. As the engine warms up the choke button should be pushed in gradually, the normal running position being all the way in.

2. To properly adjust the carburetor, see instructions starting on page 47.

3. Install new gaskets where broken or damaged and draw the manifold nuts up tight. If the manifold is cracked install a new one. This part can very seldom be satisfactorily welded. Install a new carburetor to manifold gasket is necessary.

4. Remove the float chamber cover and clean the inside of the float chamber thoroughly. Remove and clean the inlet screen at the lower part of the float chamber. If the screen is damaged install a new one. Disconnect the vacuum tank to carburetor feed pipe and clean out the pipe.

If the difficulty is found to be in the vacuum tank not functioning, see "Gasoline Will Not Flow From Vacuum Tank," page 34.

5. See remedy under "Engine Will Not Start," item No. 20, page 9.

6 and 7. See Operation Article No. 18, operation 10.

Popping in Muffler

Cause

1. Carburetor improperly adjusted.
2. Ignition improperly timed.
3. Engine missing badly, resulting from:
   Electrical trouble.
   Exhaust valves holding open due to lack of push rod clearance.
   Exhaust valves holding open due to warped or corroded stems.
   Weak exhaust valve springs.
   Exhaust valves not seating.
4. Valves improperly timed.

Test

1. See No. 2 test under "Engine Misses At All Speeds," page 11.

2. To test the accuracy of the ignition timing, disconnect the cable from No. 1 spark plug and hold the terminal about one-eighth inch from some point on the engine. Turn on the ignition. Crank the engine slowly by hand until a spark jumps from the cable to the engine. The engine should be on compression stroke and the mark "UP-DC-1-6" should be directly under the pointer in the left hand side of the flywheel housing.

The firing order is 1-5-3-6-2-4. See that the wires leading to the spark plugs follow No. 1 in that order, in a counter clockwise direction around the distributor cap.

3. See Vol. 7 to test for trouble in the ignition circuit.

To test for valves not seating properly, see "Test," item No. 20 under "Engine Will Not Start," page 8.

4. To check the valve timing, see Operation Article No. 25.

Remedy

1. Adjust the carburetor. (See instructions starting on page 47.).
2. To time the ignition refer to Operation Article No. 18, operation 10.
3. See Vol. 8 for remedy of electrical trouble.

If the valves are holding open due to lack of push rod clearance, adjust the push rods to .005 of an inch clearance with the engine warm.

If the valve stems are warped, install new valves. Corroded valve stems may be cleaned in gasoline and polished with fine emery cloth. Clean all carbon from the top of the cylinder block and valve seat. Grind the valve face to the seat in the cylinder block before installing. (See Operation Article No. 4).

If the valve springs are found to be weak, install new ones.

4. To time the valves it will be necessary to remove the front and upper gear case covers, pull the cam gear and set the gears so that the tooth marked "O" on the crankshaft gear meshes with the two teeth marked "O" on the cam gear. (See Operation Article No. 22 to remove and replace the cam gear).

Exhaust Leaks

Cause

1. Exhaust manifold leaks, resulting from:
   - Cracked manifold.
   - Loose manifold nuts.
   - Broken or damaged gaskets.
2. Muffler breaking, resulting from:
   - Stay rod nuts loose.
   - Front or rear head cracked or broken.
   - Shells cracked or broken.

Test

1. If the exhaust leaks are not easily located by volume of sound, squirt light oil around the connections noting where the oil is blown from the joint. Also test the exhaust pipe to manifold connections.

2. A leaking muffler will be indicated by an excessively loud exhaust noise coming from the muffler. Examine for:
   - Loose stay rod nuts.
   - Broken or cracked front or rear head.
   - Broken or cracked outer shell.

If no trouble can be seen it will be necessary to remove and disassemble the muffler and examine the inner shells.

Remedy

1. If tightening the connections does not overcome the leak, remove the exhaust manifold (See Operation Article No. 2) and install new gaskets.

In case of a cracked manifold it is advisable to install a new manifold rather than try to repair the old one. It cannot be satisfactorily welded.

2. If the muffler leak is due to loose stay rod nuts, tightening the nuts should overcome it. If the front or rear head is broken install new parts. It is advisable to clean the muffler thoroughly when installing the new head.

If the shells are broken or damaged, install a new muffler.

Also examine the valve and ignition timing as loose shells may be due to firing in the muffler. See "Popping in Muffler."

Exhaust Smoking

Cause

1. Excessive lubrication, resulting from:
   - Too much oil in pan.
   - Use of too light oil or oil diluted.
   - Cylinder scored.
   - Piston rings worn or weak.
2. Gasoline mixture too rich, resulting from:
   - Improper carburetor adjustment.
   - Improper carburetor float level adjustment or leaking needle.
   - Carburetor choke improperly adjusted.
3. Engine missing, resulting from:
   - Electrical trouble.
   - Valves holding open due to lack of push rod clearance.
   - Valves holding open due to warped or corroded stems.
   - Weak valve springs.

Test

1. Excessive lubrication will be indicated by blue smoke coming from the exhaust pipe.

Make tests as follows: Check the oil in the oil pan for proper quantity. This should not show above the "full" mark on the oil level indicator. If the oil level is correct drain a sample of the oil and examine it to see if it is too light or badly diluted. A fairly accurate test for this purpose may be made by trying the oil between the fingers and comparing it with new oil of the proper grade.

If the cause has not been located in the above tests, remove the cylinder head and examine the cylinder walls for scores.

Remove the pistons (See Operation Article No. 31). Remove and examine the rings.

Weak rings will allow compression to blow by the piston into the crankcase and oil to enter the

combustion chamber. The compression blow-by can often times be heard through the breather opening when the engine is running. The rings should require a weight of 8 to 11 pounds on the Big Six or 7 to 10 pounds on the Special Six to just close the gap.

Broken rings will bring about the same condition as weak rings and in addition possibly cause a ring slap when the engine is running.

Rings fitted to the cylinder with too wide a gap will give the same results as weak rings. The gap should be from .012 to .022 of an inch for plain and oil seal rings. For Perfect Circle rings it should be .010 to .015 of an inch on the Bix Six and .007 to .012 of an inch on the Special Six.

See if the rings have excessive play in the piston grooves. This will allow oil to pass back of the rings into the combustion chamber.

Also examine the rings to see that they are not binding in the piston grooves, as in this case they will not conform to the cylinder wall and will bring about the same condition as weak or broken rings.

2. Black smoke coming from the exhaust pipe would indicate that the gasoline mixture is too rich. Also the engine will not run smoothly and will load up. Check the carburetor adjustment and the carburetor float level. See page 47 for this information.

Remove the flexible air tube or open the carburetor air regulating sleeve and observe the position of the choke valve. This should be wide open or horizontal when the choke button on the instrument board is pushed in and closed tight when the choke button is pulled out. On Stromberg carburetors equipped with air cleaners the choke valve is wide open when the slot in the end of the choke valve stem is horizontal.

3. See Vol. 7 to test for trouble in ignition circuit.

To test for valves not seating properly, see "Test," Item No. 20, under "Engine Will Not Start," page 7.

Remedy

1. If the oil is too light or is badly diluted, drain it out and refill with new oil of a good quality. Use a medium oil in warm weather and a light, *cold test* oil in cold weather.

If the piston rings are weak, worn or broken install new ones.

Fit the rings into the cylinder bore and check the gap between the ends with a feeler gauge as shown in Illus. No. 39. If the gap is less than the minimum given above under "Test," the ring ends must be filed. See Piston Ring Filing Fixture C.O., Vol 8.

In case of a scored cylinder it will be necessary to rebore or hone it. This can be done with the reboring tool or hone described in Vol. 8.

Allow a piston clearance of .0035 to .004 of an inch on the Special Six and .004 to .0045 of an inch on the Big Six.

It is preferable to rebore all cylinders to take oversize pistons as it make a more satisfactory job at a small additional expense over that of boring only the cylinder that is scored.

2. Adjust the carburetor. See page 47.

Adjust the carburetor float level. If the float needle leaks due to excessive wear, install a new needle and seat. See Operation Article No. 49 or 50.

If the valve is not properly adjusted, push the choke button clear in, then loosen the set screw holding the wire and move the valve to its wide open position. Tighten the set screw in this position. Check the adjustment as described under "Test", Item 2.

3. See No. 3 "Remedy" under "Popping in Muffler."

Water in Combustion Chamber

Cause

1. Cylinder head gasket leaks, resulting from:
   Loose cylinder head nuts.
   Broken or damaged gasket.
2. Cylinder head or block cracked, resulting from:
   Water freezing in head or block.
   Filling radiator with cold water while engine is hot.

Test

1. Water leaking into the combustion chamber can sometimes be detected by an unusual amount of water coming from the muffler tail pipe; by excessive accumulation of water in the oil pan; or by the engine missing on the cylinder affected by the leak. Test the cylinder head nuts to see if they are tight. If the nuts are tight remove the cylinder head and examine the gasket.

A slight leak is sometimes rather hard to locate. In this case it is advisable to allow the engine to stand for several hours if possible before removing the cylinder head. This will allow water to leak into the cylinder affected and the leak will be more easily detected.

2. Examine the cylinder head and block for a crack. A crack can usually be located by rusty spots where the water is leaking.

Remedy

1. In case of loose cylinder head nuts, draw them down as tight as possible. If the cylinder

head gasket is broken or damaged, install a new one.

2. It is seldom possible to weld a cracked cylinder or head and keep it from being distorted and for this reason we recommend installing a new block or head in case of a crack in the combustion chamber.

To remove and replace the cylinder block, see Operation Article No. 36.

Water Leaks

Cause

1. Radiator leaks.
2. Radiator hose clamps loose; broken or damaged hose.
3. Water pump drain cock leaks; pump shaft worn or packing nut loose.
4. Broken or damaged water pump body gaskets.
5. Cracked water jacket.
6. Water header loose or cracked on gaskets damaged.

Test

1. Examine the radiator for leaks. If there is a slight leak in the tubes it may be necessary to remove the radiator and have it tested by an experienced radiator man.
2. See if the radiator hose clamps are tight. Examine for broken or damaged hose.
3. A water pump packing nut leak is often mistaken for a leaking pump drain cock as the water will follow down the drain pipe and drip from the drain cock. Examine the packing nut to see that the leak is not coming from this source before replacing the drain cock.

If the pump shaft is worn or rough the packing will wear out very rapidly.

4. Broken or damaged water pump gaskets may be indicated by leaks at the water pump body.
5. Examine the cylinder head and block for water jacket cracks. These will be indicated by water leaks.
6. Examine for crack in the water header or leaky gaskets.

Remedy

1. Radiator leaks should be repaired by an experienced radiator man.

If badly damaged install a new radiator.

2. Loose radiator hose clamps may be tightened. If the hose is damaged or broken install a new one.
3. If the water pump drain cock leaks, install a new one.

In case of a worn pump shaft install a new shaft before replacing the packing. (See Operating Article No. 20, to disassemble the pump).

4. If the pump body gaskets are broken or damaged, it will be necessary to disassemble the pump and install new gaskets.
5. Water jacket cracks which are accessible may be repaired, without welding. (See C. O. 129, Vol 8).
6. Try tightening the water header nuts evenly. If this does not stop the leak, install new gaskets. If the water header is cracked install a new one.

Oil Gauge Does Not Register

Cause

1. Oil pump not functioning, resulting from:
   - Lack of oil in oil pan.
   - Suction pipe loose, cracked or obstructed.
   - Oil too heavy or congealed.
   - Air leak at oil pump body or cover gaskets.
   - Pump gears worn or broken.
2. Oil pressure gauge, line broken or obstructed.
3. Relief valve holding open, resulting from:
   - Foreign substance on valve or seat.
4. Broken or damaged gauge.

Test

If the oil gauge fails to register any pressure whatever make tests as follows:

First test the oil level indicator to make sure there is sufficient oil in the oil pan. It should indicate between "half" and "full".

If the quantity of oil is correct then disconnect the pressure gauge pipe from the pump pipe. Start the engine and run it slowly. If oil does not flow from the pump pipe, the oil pump is not functioning.

The oil pump should be primed by pouring a quantity of oil through the pump pipe and the engine again started to see if the pump works. If the pump does not throw out the prime the difficulty is in the pump and no further test will be necessary.

If oil does flow from the pump pipe and the gauge does not register, examine the oil pump to gauge pipe to see if it is broken or obstructed.

Remove and examine the relief valve on left-hand side of the engine crankcase. The valve may be holding open due to dirt or foreign substance on the valve or seat.

If the valve is functioning and the pipe to the gauge is not broken or obstructed, the difficulty must be in the gauge. Attach one known to be correct to the pipe leading from the pump and run the engine again.

If, after priming the pump it still refuses to operate, remove the oil pan and examine for—

Suction pipe loose, cracked or obstructed.

Oil too heavy or congealed.

If the suction pipe and oil are found to be in good condition it will be necessary to remove the oil pump (See Operation Article No. 42), and examine for:

Air leaks at pump body or cover gaskets.

Worn pump gears.

Remedy

If the oil pressure gauge pipe is obstructed clean the pipe thoroughly. If it is broken install a new one.

If the gauge is defective, install a new one.

Clean the relief valve and seat thoroughly. Install a new spring if broken or damaged.

If the oil suction pipe is loose or obstructed, clean the pipe and tighten the gland nut securely.

In case of the oil being too heavy or congealed, wash the oil pan and the inside of the engine crankcase with gasoline and fill with new oil of the proper grade. Use a medium oil in warm weather and light cold test oil in cold weather. See page 37.

Worn gears or damaged pump body or cover gaskets must be replaced with new parts.

Oil Pressure Gauge Registers Low

Cause

1. Relief valve holding open.
2. Oil too light or badly diluted.
3. Oil gauge defective.
4. Leaks in oil gauge pipe.
5. Loose main or connecting rod bearings.
6. Worn oil pump gears.

Test

At 25 miles per hour the oil gauge should register approximately "2", after the engine has become thoroughly warmed up.

In case of low oil pressure it is advisable to first remove and examine the relief valve, on the left-hand side of engine crankcase, for dirt or foreign substance which might be holding the valve open.

If the relief valve is functioning properly, drain a sample of the oil from the oil pan for examination. Very light oil or oil thinned out by dilution will lower the oil pressure. A fairly accurate check for this purpose may be made by trying the oil between the fingers, and comparing it with new oil.

Extreme loose main bearings or connecting rods might cause the oil pressure to drop. This would be readily detected by a bearing knock.

Examine the pipe leading to the oil gauge for leaks when the engine is running.

By changing the oil gauge for one known to be accurate it can be checked for correct reading.

Wear on the oil pump gears should be very slight. Wear on gears due to long usage may cause low oil pressure. If no trouble is found after checking all other causes, remove the oil pump from the engine (see Operation Article No. 42), disassemble it and examine for leaking gaskets or worn gears.

Remedy

Clean the relief valve and seat thoroughly. If the spring is broken or damaged, install a new one. Never alter the spring in any way to increase the tension.

In case of too light or diluted engine oil, drain the oil pan and refill with new oil of the proper grade. Use a medium oil in warm weather and a light cold test oil in cold weather.

Low oil pressure due to loose bearings, will necessitate tightening the bearings. To tighten the main gearings, see Operation Article No. 35. To tighten connection rod bearings, refer to Operation Article No. 34.

A leak in the pipe leading to the oil gauge, caused by pipe being cracked or broken will require a new pipe. If the leak is due to loose connections, see that the oil pump pipe is screwed securely into the oil pump body. Tighten the connections at each end of the oil gauge pipe.

Never attempt to repair the oil gauge. If defective, install a new gauge.

Wear on the oil pump gears can only be remedied by installation of new gears. To remove the oil pump assembly, see Operation Article No. 42. Check the cover gasket to see that it is not thicker than .007 of an inch.

On cars equipped with Purolator, after putting the oiling system in proper condition, if the pressure is still too low, examine the relief valve to see that it has the proper number of shims.

Oil Pressure Gauge Registers too High

Cause

1. Oil too heavy or very cold.
2. Relief valve spring too stiff.
3. Defective oil gauge.
4. Oil distributor pipe, crankcase or crankshaft passages clogged.

Test

1, 2, 3 and 4. At 25 miles per hour the oil gauge should register approximately "2", after the engine has become thoroughly warmed up.

Before the oil has become warm, particularly in cold weather, the oil pressure will be higher than this. However, if it remains much too high, after the engine has been run for sometime, examine the oil to see that the correct grade is being used. See "Remedy."

If the grade of oil is found to be correct, try another relief valve spring to see if this makes a difference in the pressure shown on the gauge. If this does not reduce the pressure, it may be that the oil gauge is reading incorrectly. Replace it, with one known to be accurate. If the pressure still remains high, it is probable that there is some obstruction in the oiling system. Remove the oil pan and test the oil flow with the oil test cylinder. (See C. O. 415, Vol 8).

Remedy

1. If too heavy oil is being used in the engine, drain it out and fill with new oil of the proper grade. Use a medium oil in warm weather and a light *cold test* in cold weather.
2. Install a new relief valve spring if the old one is found to be too stiff. Never alter the spring in any way to decrease the tension.
3. If the oil gauge is found to be defective, do not attempt to repair it. Install a new gauge.
4. If the oil passageways have become clogged with dirt it will be necessary to remove the engine from the car, remove the crankshaft and main bearings, and blow out the oil passages with an air line. *Do not attempt to blow them out with the crankshaft in place because dirt will only be blown into the bearings where it will cause much damage.*

Oil Filter Fails to Operate

Cause

1. Filter inlet or outlet pipes clogged.
2. Filter body clogged.

Test

1 and 2. When the filter is functioning properly a decided flow of oil may be observed in the sight gauge "B" (Illus. No. 19) with the engine running. If this is not the case, inspect the oil gauge to see whether the oil pump is operating. If it is, disconnect the filter inlet and outlet pipes and blow them out, paying particular attention to the small orifice in the elbow attached to the oil pump pressure pipe. If, when these pipes are reconnected, the filter still fails to operate, it is evident that the filter body is clogged.

Remedy

1 and 2. The filter body cannot be repaired or cleaned. When it finally becomes so clogged with dirt that it will no longer operate, it is necessary to install a new body. See page 39.

Oil Leaks

Cause

1. Oil pan cap screws not drawn tight.
2. Damaged oil pan gaskets or end packing.
3. Damaged front gear case cover gaskets.
4. Oil throw ring improperly assembled or excessive end play in crankshaft.
5. Cylinder loose on crankcase or damaged gasket.
6. Valve dust cover not tight or damaged gasket.
7. Oil pan screen base not tight or drain valve not seating properly.
8. Oil pump pipe loose in pump body.
9. Oil pump pipe to gauge connections loose or pipe cracked or broken.
10. Oil pump bolts not drawn tight or damaged gasket.
11. Spark plugs loose or damaged gaskets.
12. Cylinder head stud nuts or cap screws loose.
13. Rear main bearing return holes clogged.
14. Generator drive shaft oil wick dislodged or missing.

Test

1 and 2. If oil is leaking around the oil pan, check the fastening bolts with a wrench to see if they are tight.

If the oil pan bolts are tight the leak may be due to damaged gaskets.

To determine the source of the leak, clean the outside of the oil pan thoroughly, start the engine and watch for the flow of oil.

Oil leaking at the front or rear of the pan may indicate damaged end packing. Oil leaking out along sides would indicate damaged side gaskets. In this case remove the pan and examine the gaskets. Also inspect the pan flanges for damage which would cause leaks.

3 and 4. Damaged gear case cover gaskets or improper clearance at the oil throw ring will be indicated by an oil leak at the front of the engine. Remove the radiator and starter clutch (see Operation Articles No. 8 and 13) and see if the gear case cover bolts are tight. Clean the gear case cover and start the engine to determine the source of the leak. If oil is leaking at the crankshaft oil throw ring, test the clearance between the oil throw ring and bronze ring on the gear case cover with a thickness gauge. The clearance should be .008 to .015 of an inch. Make this test with the clutch disengaged, this will throw the crankshaft forward and excessive end play will be indicated

by no clearance or the oil throw ring rubbing the bronze ring. Pry the crankshaft back with a small bar through the timing hole in the flywheel housing, and test again.

If oil is leaking at the gear case cover gaskets remove the cover and examine the gaskets. Broken or damaged gaskets will cause leaks. Gaskets which are too thick will result in excessive clearance at the oil throw ring and may cause a leak. Always use gaskets listed in the parts catalog.

5. Loose cylinder block to crankcase nuts or damaged gaskets will be indicated by oil leaks between the cylinder block and the crankcase.

If tightening the nuts does not stop the leak, refer to "Remedy", Item 5.

6. Oil leaks at the valve dust covers may indicate broken or damaged gaskets. If the valve cover plate nuts are found to be tight, remove the cover plate and examine the gasket.

7. Examine the oil pan screen bolts to see if they are loose. To repair a leak at the drain valve, see Item 7 under "Remedy."

8, 9 and 10. A leak at the oil pump due to the pump pipe being loose, may be indicated by low oil pressure and oil dripping from the hole at the bottom of the flywheel housing.

Examine the pipe to see if it is loose.

Leaks in the oil pump to gauge pipe may be indicated by low pressure. Examine the pipe for leaks while the engine is running.

Oil leaks at the oil pump may be indicated by low oil pressure. The pump will not function without being primed frequently. Oil leaking from the pump will drip from the hole at the bottom of the flywheel bell housing.

11. If oil leaks around the spark plugs, see if the plugs are loose or the gaskets damaged or missing.

12. Loose cylinder head stud nuts may be indicated by oil leaks at the studs or around the cylinder head gasket. Try the nuts to see if they are loose.

13. Oil leaking from the rear main bearing may result in a spray of oil coming from the timing hole in the flywheel housing when the engine is running. The clutch and inside of the flywheel housing will be covered with oil.

Remove the oil pan and the rear main bearing cap. See if the oil return holes in the cap are clogged. Also check the bearing clearance.

14. In case of oil leaking around the generator drive shaft it will be necessary to remove the front gear case cover (see Operation Article No. 19). Examine to see if the oil wick (Illus. No. 29) is dislodged or missing.

Remedy

1. Tighten the oil pan bolts.

2. If the oil pan gaskets are damaged, install new ones.

3 and 4. If the clearance between the oil throw ring and the bronze ring on the front gear case cover is incorrect due to excessive crankshaft end play it will be necessary to install a new thrust bearing. (See Operation Article No. 40).

Improper clearance not due to crankshaft end play may be remedied as follows:

Excessive clearance may be decreased by installing a paper shim under the bronze ring on the gear case cover. The thickness of the shim should be determined by the amount necessary to bring about the proper clearance between the oil throw ring and the bronze ring.

In case of the oil throw ring rubbing the bronze ring due to the throw ring not being properly assembled, remove the front gear case cover (see Operation Article No. 19). If the throw ring and bronze ring are badly worn, install new parts. Make sure that the key way in the throw ring is meshed with the key in the crankcase, when installing.

If the oil leaks are due to damaged gaskets, install new ones. Use only gaskets listed in Studebaker parts catalog.

5. Install a new cylinder block gasket. It will not be necessary to remove the cylinder block entirely to do this. It need only be raised a few inches in order to remove the old gasket and install the new one. Cut the new gasket on the bias for about one inch along one side to permit installing it.

6. In case of a damaged valve cover plate gasket, install a new one.

7. If the oil pan screen base leaks oil due to a damaged gasket, install a new gasket and tighten the bolts securely.

The oil pan drain valve is of such a type that very little trouble should be experienced with leakage. However, in case the valve leaks, disassemble it and clean thoroughly. If this does not stop the leak it will be necessary to grind the valve to a seat.

To grind the valve, coat it with fine grinding compound. Put it in place and with the handle move it back and forth in various positions exactly as in grinding engine valves.

When finished grinding, clean out all compound thoroughly and test the valve by pouring a quantity of gasoline in the screen base. It should show no signs of leakage.

8. Screw the oil pump pipe tightly into the pump body.

9. In case of a cracked or broken oil gauge pipe, install a new pipe. Make sure that all connections are tight.

10. Remove the oil pump and install new gaskets. (See Operation Article No. 42).

11. Install new spark plug gaskets if damaged. Tighten the plugs securely.

12. Tighten the cylinder head stud nuts. These should be tightened in the order shown in Illus. No. 17. The engine should then be run for five or ten minutes and the nuts tightened again.

13. Remove the oil pan and the rear main bearing cap. Clean the oil return holes in the cap and wash it thoroughly in gasoline. See Operation Article No. 35 to tighten the bearing if it is found to be loose.

14. Install a new generator drive shaft oil wick. Pack the wick securely between the pin and the case. (See Illus. No. 29).

GASOLINE SYSTEM

Vacuum Tank Does not Draw Gasoline

Cause

1. Vacuum tank screen clogged.
2. Leak in gasoline tank to vacuum tank pipe, resulting from:
   - Loose connections.
   - Pipe broken or damaged.
3. Bad air leak in suction pipe, resulting from:
   - Loose connections.
   - Broken pipe.
4. Flap valve not seating, resulting from:
   - Valve sticking.
   - Dirt under valve.
5. Screen in gasoline tank or pipe line clogged.
6. Leaky vacuum tank head gaskets.
7. Vent valve not seating, resulting from:
   - Dirt on valve or seat.
   - Worn tank mechanism.
   - Broken trip lever spring.
8. Gasoline tank filler cap vent hole stopped up.

Test

1. Failure of the vacuum tank function will be indicated by lack of gasoline in the vacuum tank. If the car is equipped with a filter the flow of gasoline from the vacuum tank into the glass bowl will be visible. If not equipped with a filter, test by disconnecting the vacuum tank to carburetor pipe at the vacuum tank. Run a piece of wire into the tank to make sure the outlet hole is not obstructed. If the vacuum tank is found to be dry it is advisable to first remove and inspect the screen in the top of the tank for dirt or other foreign substance. This screen can be reached by removing the fitting to which the main gasoline line is attached.

2. Examine the gasoline tank to vacuum tank pipe for loose connections or a broken pipe.

3. Inspect the vacuum tank to intake manifold suction pipe for loose connections or a broken pipe. An air leak in the suction pipe will cause the engine to die at idling speed.

4. To determine whether or not the flap valve is sticking, plug up the air vent in the vacuum tank head and detach the vacuum tank to carburetor pipe. Remove the filter and allow the vacuum tank to drain. Start the engine and place a finger over the outlet hole of the tank. If the suction is felt continuously then it is evident that the flap valve is not seating.

5. Disconnect the pipe line leading to the rear tank at both ends and blow through the pipe to see that it is clear.

Remove the gasoline gauge tank unit and examine the screen for dirt.

6. Remove the top of vacuum tank and examine for broken or damaged gaskets.

7. While the top of the tank is removed, inspect the mechanism and action of the valves by raising and lowering the float.

When the float is up, the suction valve should be closed tight (this can be tested by attempting to blow through the suction pipe elbow at the top of the cover) and the vent valve should be open.

When the float is down the suction valve should be open and the vent valve closed tight. With a finger over the vent hole in the vacuum tank cover flange, blow through the curved vent pipe to test the vent valve.

See that both springs are hooked in position and examine the pins for excessive wear.

8. Inspect the gasoline tank filler cap vent hole to see that it is not stopped up. It will sometimes become clogged with soap or polish after the car has been washed.

Remedy

1. Remove and clean the vacuum tank screen.

2. In case of a leak in the vacuum tank to gasoline tank pipe due to loose connections, tighten the nuts securely and if necessary install new glands and nuts. If the pipe is broken, install a new one.

3. If the suction pipe leaks due to loose connections, tighten the nuts and if necessary install new glands and nuts. If the pipe is broken install a new pipe.

4. In many cases where the flap valve is not seating, this condition can be remedied by tapping the side of the tank, thus shaking loose any particle of dirt or lint which keeps the valve from seating.

If the above operation does not remedy the trouble, remove the vacuum tank head and inner tank and clean the valve and seat.

5. Disconnect the gasoline tank to vacuum tank pipe at both ends and apply air from an air line or tire pump to clean pipe.

To clean the screen in the gasoline tank it is necessary to remove the tank and take out the gasoline gauge tank unit.

Clean the screen and replace the unit, making sure that the gasket is in good condition.

6. In case of broken or damaged vacuum tank head gaskets install new ones.

7. If the vacuum tank mechanism is found to be badly worn, install a new head assembly. This will be necessary only in unusual cases.

Replace the trip lever spring if found broken.

8. Clean the gasoline tank filler cap vent hole. Enlarge if necessary, to 1/16 of an inch diameter.

Vacuum Tank Flooding

Cause

1. Gasoline tank filler cap vent hole clogged.
2. Suction valve not closing and vent valve not opening resulting from:
   Excessive wear in tank mechanism.
   Leaky float.

Test

1. If occasionally a small amount of gasoline escapes from the air vent tube no harm will done and no adjustment is needed. If the vent tube regularly overflows examine the gasoline tank filler cap hole to see if it is clogged.

Under some conditions this will cause gasoline to flow from the rear tank filling the vacuum tank until it overflows at the vent pipe.

2. The vacuum tank mechanism may become worn from long usage. This may result in the valve not operating properly or the float sticking and allowing gasoline to rise above the normal level.

A leaky float will stay in its lower position after the tank is full. Therefore the suction valve will not close and the vent valve will not open, allowing the inner tank to fill to the top. Raw gasoline will then be drawn into the engine.

This condition should be easily detected as the engine will load up and possibly stop. If the engine continues to run, raw gasoline will be blown out of the muffler tail pipe.

To locate the leak in the float, remove the vacuum tank head and dip the float in a pan of hot water. Bubbles will be seen at the point of the leak.

Inspect the vacuum tank mechanism for excessive wear.

Remedy

1. Clean the gasoline tank filler cap vent hole. If necessary, enlarge it to 1/16 of an inch diameter.

2. If the vacuum tank mechanism is found to be badly worn it is advisable to install a new head assembly. This would be necessary only in very unusual cases.

To repair a vacuum tank float that has filled with gasoline due to a leak, remove the float by taking out the pin holding the float to the head.

Dip the float in a pan of hot water and mark the spot where bubbles are seen.

Drill or punch two very small holes opposite each other in the float to allow the gasoline to drain out. Drill one of these holes at the spot where the leak was marked. (This will eliminate the soldering of three places on the float).

Drain all gasoline from the float and then solder up the holes. Test by dipping in hot water again.

In soldering the float use no more solder than is necessary. Any unnecessary solder will make the float too heavy.

Gasoline Will Not Flow from Vacuum Tank

Cause

1. Vent tube or passage clogged.
2. Dirt in vacuum tank.
3. Vacuum tank inoperative.

Test

1, 2 and 3. A very slow flow of gasoline from the vacuum tank may indicate a clogged vent tube or passage. Examine these for dirt. If no gasoline flows from the vacuum tank, disconnect the carburetor feed pipe at the filter and unscrew the filter from the vacuum tank. Run a piece of wire into the tank outlet hole to see if it is clogged with dirt. If the vacuum tank is found to be dry, remove the fitting at the top of the tank to which the main gasoline line is attached and inspect the screen to see if it clogged. If the difficulty is not due to dirt in the vacuum tank it will be necessary to examine for the causes listed under "Vacuum Tank Does Not Draw Gasoline," page 33.

Remedy

1 and 2. Remove the vacuum tank head and inner tank and clean the inside of both tanks thoroughly. Be sure that no dirt is lodged under the flap valve. Clean the inlet screen in the vacuum tank head. This screen can be reached by removing the fitting to which the main gasoline line is attached. Clean the vent tube and passages.

If the difficulty is due to inoperative tank mechanism refer to "Remedy" under "Vacuum Tank Does Not Draw Gasoline," page 33.

GENERAL INFORMATION

The following section is one containing information of a general nature and may be used to supplement the Diagnosis and Operation Article Sections. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised paragraph will be carried at the bottom of the green sheet.

For example, the reader is interested in paragraph 9-B Flywheel Housing. Before he reads this, a glance at the bottom of the page will tell him whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the paragraph number 9-B, such as 9-B-1 or 9-B-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ENGINE LUBRICATION

In view of the fact that the life and performance of the engine are almost entirely dependent upon proper lubrication, it is of the utmost importance that the following instructions be closely observed.

1-A—Oil

It is abvisable to use a standard grade of oil produced by a reputable company, purchased in sealed containers to insure quality.

A medium oil should be used in summer or warm climates and a light, *cold test* oil in winter or cold climates.

If too heavy a grade of oil is used in cold weather it will congeal and offer excessive resistance to cranking the engine. It might also be too heavy to flow, being indicated by the oil pressure gauge not registering. If heavy oil does circulate it will be indicated by a high reading on the oil pressure gauge.

2-A—Quantity of Oil

The oil pan is filled through a filler pipe located on the right hand side of the crankcase (Illus. No. 3). In filling the oil pan see that a clean container and funnel are used.

Due to changes made in the oil pan, some of the cars built in the early part of the series require less oil than the later ones. To make sure that the proper amount is used always put in enough oil to bring the oil level indicator to the full mark. This indicator is located in the right hand side of the crankcase. (Illus. No. 3).

The level of oil should never be allowed to drop below the "half full" position, since the oil pump may not operate on a steep down grade, due to the suction pipe being uncovered.

If the pan is filled much above the "full" position, the front end of the crankshaft may dip on a down grade, splashing too much oil to the cylinders.

To check the quantity of oil in the oil pan always feel of the indicator to see if it is free to move up and down.

3-A—No Oil in Car When Unloaded

All engine oil is drained from the cars when they are loaded in freight cars. Therefore, as the cars are unloaded they must receive the proper amount and grade of oil and have the oil pump primed *before the engine is started.*

4-A—Oil Should Be Changed Frequently

The engine oil should be completely changed every 500 miles if the car is not equipped with an oil filter. If equipped with an oil filter the oil should be changed every 1000 miles in warm weather and every 500 miles in cold weather. If the car is not driven this far in a month, the oil should be changed once a month regardless of mileage.

Cars in short trip service, in cold weather, on account of extreme dilution of the oil should have the engine oil changed every 300 to 500 miles.

5-A—Oil Pan Drain Valve

The oil pan drain valve is located in the oil pan strainer base and is operated by a lever in the right hand side of the crankcase. The valve is opened by turning the lever clockwise.

The oil pan drain valve is of such a type that very little trouble should be experienced as to leakage.

However, in case the valve leaks it should be examined for dirt. If the valve and seat are clean and not damaged in any way it will be necessary to grind the valve to a seat.

This is accomplished by removing the valve and screen base as described in Operation Article No. 28. To grind the valve, coat it with fine grinding compound. Put it in place and with the handle "D" (Illus. No. 42) move it back and forth in various positions exactly as in grinding motor valves.

When finished grinding, clean out all compound thoroughly and test the valve by pouring a quantity of gasoline in the screen base. It should show no sign of leakage.

6-A—Do Not Flush Out Engine Oiling System

It is common practice, when changing the engine oil, to flush out the oiling system before putting in the new oil. In cars with force feed lubrication, this should never be done.

All oil passages communicate with the main and connecting rod bearings and flushing or blowing out these passages will only carry the sediment into the bearings with disastrous results.

Under ordinary circumstances the small amount of sediment which passes the screens will collect in the corners of the passages and be out of cir-

culation. Only under abnormal conditions can enough enter the system to retard the flow of oil. The only remedy in this case is to remove the crankshaft before cleaning. On cars equipped with an oil filter, the oil is kept practically free from dirt and the possibility of stoppage of the flow of oil from this cause is slight.

In place of flushing, we recommend removing the oil pan, and washing all parts in gasoline. This should be done at least every six months and more often in cold weather.

The oil pan strainer should be removed once a month and thoroughly cleaned, being careful to keep it free from lint.

7-A—How to avoid Oil Dilution and Sludge Formation

Oil dilution and the formation of sludge can be controlled to some extent by carefulness on the part of the owner. The following information supplied to the owner will aid him in keeping his engine lubrication system in proper condition:

Avoid excessive use of the choke. After starting give the engine time to warm up somewhat before driving.

Use a radiator cover during the winter to allow the engine to warm up more rapidly and also to run at a higher temperature. A cold running engine acquires dilution much more rapidly than a hot one because all the fuel injected into the cylinders does not burn. Some of it finds its way into the oil pan. Heat aids vaporization and promotes perfect combustion.

A radiator cover will also reduce water formation in the crankcase. Water, if allowed to collect in the oil circulation system, will pocket and freeze very readily, stopping the circulation of oil.

Avoid idling for long periods or excessive slow driving. Very low speeds tend to increase the dilution of the oil.

Change the oil at least every 1000 miles. Be sure to use the correct grade of oil. (See page 37).

Remove the oil pan every six months and clean it thoroughly. In extremely cold weather it may be advisable to do this more often.

Clean the oil screen in the oil pan once a month, being careful to keep it free from lint.

Once or twice a week in cold weather drain a cupful of oil from the crankcase. This should be done while the engine is warm but after it has been allowed to stand idle for about ten minutes. If there is any water present this will remove it.

The fuel has something to do with water accumulation, and oil dilution. High test gasoline generally gives better satisfaction in cold weather as the engine warms up more quickly.

If sludging should occur, make sure that the last trace of the formation is cleaned from the crankcase before renewing the oil. Remove the oil pan and clean it and the inside of the crankcase thoroughly.

If this is not properly done sludge will be formed in the new oil with surprising rapidity.

8-A—Oil Distributor Pipe

With a force feed oiling system it is essential that every joint be tight in order to maintain pressure and flow of oil.

If the distributor pipe is removed care must be taken to replace it properly and see that the glands at the crankcase webs are properly sealed. New glands should always be used and the entire system must be tested for leaks as described under C. O. 415 Vol. 8.

9-A—Oil Pump Gaskets

New gaskets should always be used when working on the oil pump. The expense of removing the oil pump to change a gasket which was thought to be in fair condition warrants this in every case.

Unless good gaskets are used and are properly assembled, air leaks will result, causing failure of the pump to function.

Do not use white lead or any similar material around the oil pump.

A light coat of shellac may be applied between the gasket and the pump body to hold the gasket in position but never apply shellac between the crankcase and the gasket.

When assembling the cover gasket, coat it with oil but do not use shellac.

If new gaskets are not obtainable they may be cut from the proper material. Oil proof paper, 1/32 of an inch in thickness should be used for the body gasket. For the cover gasket use bond paper, .0065 to .007 of an inch thick. The thickness of the cover gasket is very important to insure proper functioning of the pump and care should be exercised not to use paper thicker than specified.

2-A-1—Quantity of Oil

Beginning with Big Six engine Nos. ES 60381 and EW 24828 a bayonet type oil level indicator is used, replacing the float type formerly used. This indicator is located in the right-hand side of the crankcase directly below the oil filter and must be withdrawn to read the oil level which can be checked by the grooves on the end of the rod marked "E" and "F" indicating the empty and full position. The oil level should not be allowed to get much below the full position.

5-A-1—Oil Pan Drain Valve

The oil pan drain valve and strainer base assembly formerly used has been discontinued in production. Beginning with Big Six engine Nos. ES 60381 and EW 24828 a drain plug located in the right hand side of the oil pan, with a square depression in the head which fits the jack handle, is used to drain the engine oil.

Issued October 15, 1927
Insert in Volume Three, after page 38.

PRINTED IN U. S. A.

10-A—Pump Gears Worn

Badly worn gears are the result either of long usage or of continued use of dirty oil. Excessive wear on teeth or face of gears may cause the pump to lose its prime or at least lower its efficiency.

To remove and replace the gears, remove the oil pump (See Operation Article No. 42) and then remove the countersunk screw holding the cover to the body.

When replacing the gears, see that they do not bind after the cover and cover gasket have been assembled.

11-A—Oil Filter

The inlet pipe of the oil filter is tapped into the oil pressure gauge line. A portion of the oil is thus sent from the pump to the filter where the sediment is removed. The filter outlet leads to a hole in the right hand side of the crankcase.

The filter ordinarily requires no attention whatever. With the dash mounted type of filter a decided stream of oil should be visible in the sight gauge when the engine is running. The operation of the filter mounted on the engine can be checked by opening the test valve at the top of the filter. A few filters of this model had a removable test plug in place of the test valve. When the test valve or plug is opened a decided stream of oil should result. This indicates that the filter is functioning correctly.

If the filter fails to operate, first look at the oil pressure gauge on the instrument board to determine if the pump is operating.

If the pump is operating properly, disconnect the filter inlet and outlet pipes and blow them out. Then remove the test valve assembly from the top of the filter body and thoroughly blow out the passages.

Failure of the filter to function after the above operations will mean that it has become so clogged with sediment that no more oil can flow through it. This can only happen after long mileage and the filter body must then be replaced with a new one. By disconnecting the oil lines at the filter and removing the bracket bolts the filter can be removed and replaced.

Failure of the filter to operate will have no ill effect on the engine lubricating system other than permitting sediment to accumulate.

12-A—Oil Filler Pipe Baffle

Whenever the oil filler pipe is removed from a Big or Special Six, care should be taken that the baffle plate is not bent out of shape.

The correct position is indicated by the words "Top Outside" stamped on the plate. The lip should stand open at an angle of 30 degrees.

This part went into production with Big Six engine No. EP 13311 and Special Six engine No. EQ 41381.

13-A—Oil Pressure

The oil pressure gauge should register approximately "2" at 25 miles per hour, after the engine has become thoroughly warmed up. For higher speeds it should show slightly more pressure. This pressure applies to all models up until the time the "Interchangeable Type" bearings entered production in Big Six engines.

Beginning with engine Nos. EW 12029 and ES 59250 a change was made in the main bearings, oil pump, relief valve, crankshaft and oil pressure gauge which raised the oil pressure. After the engine is warmed up the gauge on these models should register about "6" when the engine is idling, "25" when running at 25 miles per hour and "30" when running at 30 miles per hour.

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CYLINDER HEAD AND CYLINDER BLOCK

1-B—Compression Leaks

The general efficiency of the engine is often lowered by numerous small compression leaks which waste power. This may be caused by loose cylinder head nuts, cylinder head gasket broken or damaged, priming cups loose or damaged, spark plugs loose or damaged, spark plug gaskets missing or damaged.

In case of damaged priming cups, spark plugs or gaskets, it is advisable to use new ones.

2-B—Carbon in Cylinders

Carbon being the natural result of the combustion of gasoline and oil, it is therefore to be expected that it will accumulate to some extent in every engine.

Rapid accumulation of carbon may be due to excessive lubrication, poor grade of oil, scored cylinders, weak piston rings, valves not seating properly or improper carburetor adjustment.

To clean out the carbon, remove the cylinder head and gasket and scrape the carbon from the top of the cylinders and pistons and from the cylinder head.

Polishing the combustion chamber by means of an electric drill and a wire brush will aid greatly in reducing subsequent carbon deposits.

As a further aid in minimizing deposits, the owner should be given the following information.

Use nothing but the highest quality oil of the proper body and character. The recommendations of the leading oil manufacturers may be relied upon.

Examine the oil level indicator daily and keep the oil at the proper level. Do not overfill. Overfilling causes over-oiling and carbon formation.

Do not, to increase the oil pressure, shift to an oil heavier than is recommended. Extreme dilution of the oil (due to neglecting to change the oil at proper intervals) may cause the pressure to drop. This, of course, is remedied by draining the oil and refilling with new oil of the correct grade.

The indiscriminate use of heavy-bodied or low-quality lubricant is a most frequent cause of fouling spark plugs, sticking valves, prolific carbon formation and "carbon knock" or detonation.

Be sure that the carburetor is properly adjusted and do not drive with the choke out any longer than is necessary. With a rich mixture, carbon forms from the incomplete combustion of both oil and gasoline, and the excess fuel dilutes the oil.

"Missing" of the engine promotes over-oiling and carbon formation, inasmuch as there is incomplete combustion, and carbon forms in about the same manner as with a rich mixture.

Compression losses lower the efficiency of combustion and the ability of the burning fuel charge to dispose of the excess oil. Therefore, keep the valves properly ground in, the tappets properly adjusted, priming cups and cylinder head gasket tight, and use the correct grade of engine oil.

3-B—Scored Cylinders

Scored cylinders are in most cases caused by lack of proper lubrication to the piston and cylinder walls or by failure of the cooling system.

Scored cylinders may also result from driving, at too high speed, a new car or one in which new pistons and rings have recently been installed. Also by driving the car too hard during the initial period of warming up the engine before the oil has had a chance to reach the cylinder walls.

Failure to properly anchor the piston pins in the connecting rods or fitting the pistons and rings too tight in the cylinder may result in scored cylinders.

Scored cylinders may be indicated by poor compression or loss of power, compression blowing by the piston into the crankcase and excessive oil consumption. However, the only positive method of locating a scored cylinder is to remove the cylinder head and inspect each cylinder with the piston at bottom dead center.

A scored cylinder should be rebored (up to .010 of an inch the hone may be used) to take the smallest oversize piston which will thoroughly clean up the cylinder. Pistons of various oversizes may be obtained from Service Stock. If a large oversize piston is to be used it is preferable to rebore all cylinders at the same time, as this makes a more satisfactory job at a small additional expense over that of reboring only the cylinder that is scored. (See Vol. 8).

4-B—Cylinder Head Studs Loose in Cylinder Block

Cylinder head studs are securely threaded in the

cylinder and seldom become loose. However, they should always be inspected before replacing the cylinder head and tightened if necessary.

This can be done by locking two nuts on the upper end of the stud and applying a wrench to the top nut. When removing the nuts, hold the bottom nut with a wrench while unlocking.

Stud drivers can also be obtained for this purpose.

CRANKSHAFT AND CRANKCASE

5-B—Main Bearings

The bearings should never be molested unless there is actually a bearing knock. When this occurs, the correct procedure is to install new bearing shells using a line reamer. Ordinarily this will not be necessary except after long mileage but might be required under extraordinary circumstances such as running without oil.

Line reaming should always be used. The need for proper clearance and a perfect bearing is much greater with pressure lubrication than with the splash system and this is the only method that will insure proper clearance and entirely satisfactory results. Once in a while, however, an emergency may require bearing adjustment. While this is never recommended if not absolutely necessary, instructions have been given in Operation Article No. 35 which should be followed to get as good results as can be expected under this method.

No difficulty need be anticipated from an excessive flow of oil due to loose bearings as a knock will be noticed before the former condition requires attention.

If no line reamer is available the crankcase may be sent to the factory for the installation of new bearings. It is not recommended that main bearings be scraped by hand.

When replacing bearings which have burned out, remove the oil distributor pipe and carefully clean it and all passageways in the crankcase and crankshaft.

Shims are entirely dispensed with in the bearings. This will necessitate dressing down the surface of the bearing cap if adjustment is made. It is highly important, to insure proper lubrication after this operation, that the bearings have a clearance of .0015 to .002 of an inch. Follow carefully the Operation Articles when working on the bearings.

6-B—End Play in Crankshaft

Rapid wear on crankshaft or thrust bearing flanges causing excessive end play in shaft, can be attributed to the habit of driving with the foot resting continually on the clutch pedal. The owner should be cautioned against this practice.

7-B—Crankshaft Bearing Surfaces Rough

The crankcase should be handled carefully at all times to prevent damaging the bearing surfaces.

If burrs or rough spots are found on the shaft they should be removed with an oil stone or very fine emery cloth and oil, before replacing the shaft or installing new bearings.

Ridges, if very pronounced, can be removed by grinding or very careful filing and polishing. (See also Crank Pin Re-Turning Tool, Vol. 8).

If new bearings were installed with rough spots on the shaft, the bearings would soon loosen up, causing a knock or possibly causing the bearings to burn out.

8-B—Camshaft

It is seldom, if ever, necessary to replace a camshaft due to breaking or springing of the shaft, or wearing of the cams and bearings. Should this occur, it is usually the result of lack of lubrication, causing the camshaft to freeze in the bearings.

We do not recommend regrinding cams or bearings or straightening a sprung shaft. Only a new shaft can be safely used.

9-B—Flywheel Housing

The rear engine supports and flywheel housing are a casting separate from the crankcase. The rim of this housing must be concentric with the crankcase in order to properly line up the transmission when it is bolted on. To accomplish this, the two bolts holding the legs on the front of the housing to the crankcase are a reamed fit and act as dowels to locate the housing. It should very seldom be necessary to remove this housing and this should not be done unless absolutely essential, and then great care must be taken to see that it is put back properly. In replacing the housing put

in the two bolts holding the legs on the front of the housing to the crankcase and draw them tight. With the housing thus located the remaining bolts can be put in place.

Should it become necessary to replace a flywheel housing it will be found that the new housing has a certain amount of machining stock on the rim to which the transmission bolts. This is order that the housing may be bolted to the crankcase and the rim machined, in place, to make it concentric with the crankshaft. This operation is fully described under C.O. 425, Vol. 8.

10-B—Generator Coupling Bumpers Worn or Improperly Assembled

When the rubber bumpers become worn allowing play in the coupling, they should be replaced, as bumpers in this condition will go to pieces rapidly. This will allow the metal lugs of the couplings to come in contact, causing a knock and also wearing the lugs so that the coupling will need replacing.

PISTON AND CONNECTING ROD

11-B—Piston Clearance

There is no definite clearance at which it is necessary to change a loose piston as often times the piston slap is so slight as to be unnoticeable.

If the piston is round and the cylinder bore is true and in good condition the following clearances will be found satisfactory:

Big Six (3⅞ inch bore)—.004 to .004½ of an inch.

Special Six (3½ inch bore)—.003½ to .004 of an inch.

Pistons fitted too tight will result in scored cylinders and pistons, due to the fact that the proper oil film cannot be maintained between the piston and cylinder. For this reason, the clearances given above must be adhered to and the car must receive, for a reasonable length of time, the same treatment accorded a new car. The most accurate way of determining piston clearance is by using a micrometer on the piston and a cylinder test indicator in the cylinders. However, feeler gauges, if properly used, will give good results. (See C.O. 66, Vol. 8) for instructions on the use of feeler gauges.

12-B—Pistons Rings

To determine the exact condition of the piston rings it is necessary to remove the piston and connecting rod assembly.

Rings which are properly fitted can be rolled around the grooves as shown in Illus. No. 37, without binding at any point. Plain and oil seal rings should have a gap of .012 to .022 of an inch, when placed in the cylinder as in Illus. No. 39. For Perfect Circle rings the gaps should be .010 to .015 of an inch on the Big Six and .007 to .012 of an inch on the Special Six.

It will require a pressure of 8 to 11 pounds to just close the gap on Big Six rings and a pressure of 7 to 10 pounds on Special Six rings.

The rings should have no up and down play in the piston grooves as this would allow compression to escape back of the rings and oil to work up into the combustion chamber.

13-B—Piston Pin

When fitting new piston pins be very careful not to fit them too tight. If properly fitted, the rod should carry down very easily of its own weight when the piston is held in the hands. When fitted too tight the pin will wear very rapidly and perhaps seize. Pins which have been in this condition can be detected by a blue or brown appearance at the bearing surfaces.

Other causes of loose piston pins are improper lubrication and normal wear through long usage.

If the pins are only slightly worn the bushings may be reamed out and oversize pins installed. However, the most satisfactory way to insure a perfect bearing and fit is to replace both pin and bushings. See Operation Article No. 33.

Be sure that the pin is anchored securely in the rod so that there will be no possibility of its loosening and scoring the cylinder wall.

14-B—Connecting Rod Bearings

As in the case of main bearings, the connecting rod bearings should be left alone until a bearing knock actually develops. This will ordinarily not occur except after long mileage. Then, to secure entirely satisfactory results, the rods should be rebabbitted and reamed to size.

5-B-1—Main Bearings

The following revision has been made in the main bearings starting with Big Six engines EW-12029 and ES-59250.

The new main bearings are of the type termed "interchangeable", meaning that new bearings can be used without the customery reaming operation. They are *not* interchangeable with the previous type shells which do require reaming.

These bearing shells are accurately machined to size and should never be line reamed or hand-scraped. Also stock should never be removed from the bearing caps to obtain an adjustment as this will render the caps useless when new main bearing shells are installed.

The new main bearings will give long mileage and when it becomes necessary to replace them due to wear or lack of lubrication, the upper and lower bearing shells in all four bearings must be replaced. *Never install less than a full set of bearing shells*, otherwise misalignment of the shaft is sure to result.

When bearing replacement becomes necessary, either the standard size shells or one of the three undersizes are used, depending upon the condition of the shaft. Bearing shells are furnished in four sizes: Standard, .005, .010 and .015 of an inch undersize.

The standard size shells may be used if the crankshaft is not worn or out of round more than .002 of an inch. If it is worn or out of round more than .002 of an inch it will be necessary to grind the crankshaft down until it is perfectly round. The shaft should then be measured and the grinding continued until the shaft is exactly .005, .010 or .015 of an inch undersize and the corresponding size of bearing shells installed.

The original sizes of the crankshaft journals are given below in the following table:

Front	2.468 to 2.469
Front Center	2.499 to 2.500
Rear Center	2.530 to 2.531
Rear	2.561 to 2.562

These figures must be used as a starting point when it is found necessary to grind down the crankshaft for undersize bearings.

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Reaming should be always used in preference to hand scraping to seat the bearing. The need for proper clearance and a perfect bearing is much greater with pressure lubrication. See Connecting Rod Reamer in Vol. 8.

If for some reason it is necessary to scrape them by hand, they should be scraped in the usual way until an evenly distributed but lightly spotted bearing surface is obtained. With the bearing cap assembled, after this operation, the rod should turn about the shaft very easily.

Important — Before replacing a burned out rod, the engine must be removed and all passageways in the crankcase, distributor pipe and crankshaft thoroughly cleaned out. To do this properly the crankshaft main bearing shells and distributor pipe must be removed. While at first thought, this may seem to entail considerable extra labor, it is essential. *If it is not done, particles of babbitt left in the oil circulating system will stop the flow of oil, and will be almost sure to result in more burned out bearings.*

In case of emergency, it may occasionally be found necessary to adjust the rod bearings instead of following the better practice of installing rebabbitted rods. In order to obtain as good results as possible by this method follow closely instructions in Operation Article No. 34. Shims are entirely dispensed with. This will necessitate dressing down the bearing cap if adjustment is made. It is highly important, to insure proper lubrication after this operation, that the bearings have a clearance of .0015 to .002 of an inch. This can be checked as outlined in the above operation article.

15-B—Valves and Push Rods

If the crankshaft or camshaft gears have been removed, the only precaution necessary in replacing them is to see that the tooth marked "O" on the crankshaft gear is meshed between the two teeth marked "O" on the camshaft gear (Illus. No. 11).

Correct valve timing is necessary before the engine can be expected to give proper performance. Late or early valve timing will be indicated by lack of power. If the gears are assembled according to the marks, there should be no reason for the engine being out of time. However, this can be easily checked any time after the engine is assembled by following instructions in Operation Article No. 25.

Be sure that incorrect timing is not caused by insufficient or excessive clearance between the push rod adjusting screws and the valve stems. See "Adjusting Push Rods" below.

16-B—Adjusting Push Rods

Clearance between the push rod adjusting screws and the valve stems should be adjusted as shown in Illus. No. 47 to not less than .006 of an inch or greater than .008 of an inch. On busses and passenger cars subjected to hard service the exhaust valves should never be set closer than .010 of an inch. Check the clearance with a thickness gauge as shown in Illus. No. 48. Adjustment should always be made with the engine hot. However, if it is necessary to adjust the push rods with the engine cold they should be set to .008", making a final adjustment to the correct clearance with the engine hot.

Adjustment should not be made with a view of gaining extreme silence at this point but to obtain the most quiet adjustment possible with the minimum clearance given.

Push rods adjusted too tight will cause burning or fouling of the valves and incorrect opening and closing of the valves, with consequent loss of power and lowered gasoline economy.

17-B—Valve Springs

Valve springs should compress to 1 13/16 inches under pressure of 45 to 50 pounds.

Some loss of tension may occur after long use. Weak springs will be indicated by the engine missing at high speeds and clattering of valves when closing the throttle.

18-B—Sticking Valves

Sticking valves are usually caused by accumulation of carbon on the valve stems and in the guides, warped valve stems or insufficient push rod clearance. A somewhat similar condition will result from excessively weak valve springs.

A sticking valve will cause that cylinder to cut out entirely and may be readily detected by excessive noise from the push rod.

When installing new valves and guides be very careful to allow proper clearance between the stem and the guide. This is necessary to prevent seizing of the valve stem. See Tolerance Chart, page 57.

19-B—Push Rod Guides Loose in Cylinder Block

This condition can only be caused by the push rod guide clamp "B" (Illus. No. 48) not being kept tight or being installed up side down. This must always be installed with arch up.

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COOLING SYSTEM

1-C—Water Pump Impeller Broken or Pin Sheared

This can only be caused by attempting to crank the engine when the water in the pump is frozen and will be evidenced by the water not circulating with the engine running at medium speed.

2-C—Fan Belt

A slipping fan belt is caused from the belt stretching or from oil on the belt. A broken belt is the result of too tight adjustment or natural wear. Either of these conditions will allow the fan to revolve too slowly or not at all, thereby causing the engine to overheat.

Under ordinary circumstances a belt will not slip if kept clean and properly adjusted. However, an occasional application of belt dressing may be used if it seems necessary and will help to preserve the leather.

Always install the belt with the smooth side toward the pulley.

For belt adjustment on cars carrying the rigid fan mounting see Operation Article No. 10.

On cars carrying the automatic belt adjustment, the fan will require less attention, as under normal conditions there is no possibility of the belt loosening.

However, it should be examined periodically. The belt is properly adjusted when, with the engine not running, it requires reasonable difficulty to turn the fan by hand. The proper tension may be obtained by turning the thumb nut on the adjusting screw.

Too much tension on the belt will cause it to stretch and wear rapidly.

3-C—Radiator Leaks

Radiator leaks are usually caused by rough handling, allowing water to freeze in the radiator or the use of improper cooling solution in freezing weather.

It is advisable to have radiator repairs made by some one experienced in this line of work. If you do not have enough of this class of repair work to warrant hiring such a man it would be advisable to send it to a specialty shop.

4-C—Anti-Freeze Solution

An anti-freeze solution should be used for winter driving. A very satisfactory solution is one of denatured alcohol and water.

Following is a table of denatured alcohol solution freezing points:

Denatured Alcohol (By Volume)	Water (By Volume)	Begins to Freeze (Degrees Fahr.)
10%	90%	27
20%	80%	19
30%	70%	10
40%	60%	-2
50%	50%	18

Distilled glycerine may also be used in preparing an anti-freeze mixture. The initial cost is greater than alcohol but it has the advantage of not evaporating so that in a season's running it is likely to prove less expensive than alcohol. Be sure to use distilled glycerine and not the ordinary commercial grade.

If it is desired to use glycerine, it should be mixed according to the following table:

Distilled Glycerine (By Volume	Water (By Volume)	Begins to Freeze (Degrees Fahr.)
15%	85%	25
25%	75%	18
35%	65%	6
40%	60%	0
45%	55%	— 8
50%	50%	—15

When mixing the solution, always drain the water from the radiator, mix the ingredients in a separate container and fill the radiator with this mixture. This is important to insure mixing the solution thoroughly.

If alcohol is used it will occasionally be necessary to replenish with additional mixture due to evaporation of the alcohol. In this case fill the radiator with a mixture containing a slightly larger proportion of alcohol.

If glycerine is used only water need be added to maintain the proper level.

17-B-1—Valve Springs

A new type valve spring has been released under part No. 114842 for use on the Big Six engines to help stablize the valve action at high speeds.

This spring entered production with engine Nos. EW 717 and ES 56,916 and should compress to 1 and 13/16 inches under pressure of 55 to 60 pounds.

5-C—Thermostat

A thermostat has been placed in production on all Big Six engines. This warms the engine up to an efficient running temperature more quickly. The valve starts to open at approximately 150° F. and is controlled by two special alloy springs connected to the valve by means of an arm.

There should be no adjustment attempted on the thermostat valve.

A new type cyclinder head gasket was released with the thermostat and must be used on all engines equipped with thermostats.

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STARTER CLUTCH

1-D—Lubrication

Never use anything but *engine oil* to lubricate the starter clutch. Heavy oil or grease will cause the clutch to slip. In this case it must be disassembled and thoroughly cleaned with kerosene.

If the clutch is not lubricated at proper intervals as shown on the lubrication chart it is very liable to stick and not release properly. It is usually possible to correct this by lubricating it. If not, however, it must be removed and cleaned. (See Operation Article No. 14).

When reassembling the clutch lubricate the three oiling felts "K" (Illus. No. 56) thoroughly.

2-D—Starter Clutch Bushing Worn

A worn starter clutch bushing is indicated by ability to move the sprocket sidewise.

This is very seldom encountered and is the result of long usage or improper lubrication. See Operation Article No. 13 to replace the bushing.

VIBRATION DAMPER

3-D—Inspection

If the vibration damper is properly assembled and free from dirt and oil it should function properly.

To check this, draw a chalk line across the disc and starter clutch hub. After running the engine at a speed equivalent to a car speed of 30 miles per hour and accelerating occasionally, the chalk marks should separate as in Illus. No. 9. If they do not, the damper is not functioning and should be disassembled, inspected and cleaned. (See Operation Article No. 15).

MUFFLER

4-D—Clogged with Carbon

A clogged muffler or exhaust pipe will cause back pressure on the engine, resulting in loss of power, overheating and rapid accumulation of carbon. In extreme cases it will be impossible to start the engine.

Cases of this kind are very seldom found but it will be necessary to disassemble the muffler and clean it and the exhaust pipe.

5-D—Muffler Shells Loose

The muffler shells being loose or blown out, is, in many cases, due to firing in the muffler. This, in turn, may be caused by an exhaust valve holding open or to the engine being out of time. It is also frequently due to the driver's habit of coasting down hill with the ignition off and the transmission in gear. The owner should be cautioned against this practice, as it fills the muffler with unburned gas which explodes when the ignition is again turned on.

GASOLINE SYSTEM

1-E—Gasoline Tank

Before repairing a leak in the gasoline tank, always remove the tank from the car. Drain out all gasoline, blow the tank out thoroughly with air and allow it to stand for some time. Before starting to solder, blow it out with air again, making sure that all gasoline fumes are out of the tank.

Do all soldering with a soldering iron. NEVER USE A FLAME.

2-E—Gasoline Gauge—General Inspection and Adjustments

Disconnect the rear end of the fuel line. If gasoline leaks from the hole where the line was attached, drain enough gasoline from the tank to stop its leaking and then reconnect the line to the tank. This operation applies only to cars which have the tank unit mounted on the front side of the tank. See that the air line connection at the tank is tight.

Remove the gasoline tank filler cap. See that the vent in the cap is free and open. Do not replace the cap at this time.

Warning—Do not remove the gauge from the instrument board.

Disconnect the gauge line at the front end from the gauge head and make the gauge read exactly zero by adding or removing liquid as may be necessary. The liquid can be added or removed at the top of the brass tube where the air line has been disconnected.

To add liquid, use a medicine dropper, being careful not to overfill. To remove liquid, use a tooth pick or match. *Use only K-S Telegage Liquor, no other will do.* The liquid is specially selected because of its specific gravity and other characteristics.

Blow out the air line with a hand tire pump. (Never blow with the mouth or shop air line as these contain moisture which may pocket in the air line and affect the reading of the gauge). Cut the metal connection from the tire pump hose for this purpose. Push the hose securely over the front end of the air line and give 40 full strokes.

Before connecting the air line, see that the gauge holds its reading and therefore does not leak. Connect the air line and replace the gasoline tank filler cap.

After making the above adjustments, test as follows:

A. To determine whether you can bring the gauge up to the proper reading by supplying air to the tank unit, a short cut test can be made by removing the fuel feed line from the top of the vacuum tank and blowing back with the mouth into the main tank.

B. The only complete check of air supply, however, is to drive the car until the red liquid no longer comes up. If the reading will stay set with the engine dead, the telegage is O. K. If you cannot get a reading by driving or blowing back through the line or if the reading drops and will not stay set with the engine dead, see the following tests:

1. Disconnect the air line front and rear to test for leak.
2. Inspect the connections for dirt and flaws.
3. Have someone hold a finger over one end of the pipe. If suction created with the mouth on the other end of the pipe will hold the tongue for one minute the air line is in a serviceable condition.
4. If the air line shows a leak, install a new one.
5. If the air line is not defective the difficulty is in the tank unit which should be changed.

Caution—Whenever repairs are made on the telegage, the air line should be blown out from the front end to clear it of any gasoline which may have been driven into the line when it was disconnected.

The telegage provides a reserve of approximately one gallon of gasoline, that is the bottom gallon in the tank never shows on the gauge. Above this point the gauge reads exactly, gallon for gallon, all gasoline put in the tank.

3-E—Vacuum Tank Operation

By means of an arrangement of four levers and two springs, the float in the inner or vacuum chamber operates the suction valve and the atmospheric valve. See Illus. No. 69.

When the vacuum chamber is empty the float is down, the atmospheric valve is closed and the suction valve is open. The suction of the intake manifold is applied to the inner chamber through the vacuum connection and reduces the pressure in

6-D—One Piece Muffler

The muffler now in use entered production with Big Six number 2083191 and Special Six serial Number 3169042.

This muffler is of the clinched end type, and is not repairable, but must be replaced with a new one if it is clogged or blown out. The old type muffler has been discontinued and the new one will be carried in the service stock for all models.

The old frame brackets can be bent and redrilled to fit the new muffler.

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the inner chamber below that of atmospheric. This closes the flap valve as the outer chamber is at atmospheric pressure. The fuel from the main supply tank is, therefore, drawn into the inner chamber, passing through the screen in the cover.

As the inner chamber fills with fuel the float rises. When the float reaches the top of its stroke the spring lever is pushed above the pivot causing the springs to lift the valve lever which closes the suction valve and opens the atmospheric valve, allowing the fuel to flow into the lower chamber and from there by gravity into the carburetor.

This operation is continued at a rapid rate until the fuel level in the outer chamber comes to a balance with the fuel level in the inner chamber and therefore operates as the carburetor demands fuel.

4-E—Air Cleaner

The air cleaner has no moving parts and is self-cleaning. It will therefore, require no attention whatever.

5-E—Gasoline Filter

The gasoline filter furnished on some cars is attached to the outlet of the vacuum tank. Since the gasoline flows in and out of filter at the top, this permits water and dirt to settle on the bottom of the bowl, undisturbed.

When the filter collects enough dirt or water to restrict the flow of gasoline is will be easily visible through the glass bowl. To clean the filter unscrew the bolt at the bottom of the glass bowl and remove the bowl and screen.

STROMBERG CARBURETOR

6-E—Operation

The Stromberg Carburetor used on the Special Six is the Plain Tube Type, so-called because of having no air valves or metering needles. Both the air passage and gasoline jets are of fixed size for all engine speeds.

This carburetor is the Stromberg Model L S-2 and contains the following special features:

A gasoline feed above the throttle, with separate adjustment for idling the engine

An accelerating well, which gives an extra supply of fuel for a moment as the throttle is opened.

An economizer, which permits the carburetor to operate on a very lean and economical mixture at the closed throttle position of average driving, but automatically shifts to the richer setting when the full power of the engine is called for.

7-E—Adjustments

Do not start to change the carburetor adjustments until the points listed below are thoroughly covered.

1. See that the spark plugs are spaced to .025 of an inch.

2. See that the breaker points on the distributor are set to .020 of an inch.

3. See that all cylinders have good compression; it may be that some of the valves are held open by improper adjustment of valve clearances. (See Operation Article No. 6).

4. The engine should be warmed up to the normal running temperature before making any adjustments.

8-E—High Speed Adjustment

It is impossible to enrich the mixture with the high speed adjustment beyond the quantity controlled by the gasoline reducer jet (Fig. 1, Illus. No. 78). It is, however, possible to reduce this quantity by means of the high speed adjustment to any leanness desired.

Turning the high speed adjusting screw (Fig. 5, Illus. No. 78) OUT gives a richer mixture and IN a leaner one.

First turn the high speed needle out about four turns.

Start the engine and set the throttle to give an engine speed corresponding to a car speed of about 25 miles per hour.

Turn the needle to the right or in, a notch or two at a time. The engine will first begin to slow down and then start to run unevenly. As soon as the engine begins to run unevenly turn the needle back until it runs steadily.

This adjustment will give the leanest possible mixture for satisfactory performance. On the average car the needle will then be between 3 and 3½ turns out from the closed position, depending on the temperature, altitude and condition of the engine.

The needle should never be turned out more than 3½ turns.

Note—The carburetor adjustment on new cars necessarily borders on the rich side because of the engine being new. Therefore, the adjustment must be made leaner, as instructed above, as the engine becomes worked in.

Avoid adjusting the carburetor too lean, as this will necessitate excessive use of the choke resulting in fouling of spark plugs, dilution of engine oil and excessive gasoline consumption.

9-E—Idling Adjustment

Turning the idling adjusting screw (Fig. 5, Illus. No. 78) IN gives a richer mixture and OUT a leaner one.

First turn the idling adjusting screw all the way in and then turn it back two turns.

Start the engine and with the throttle closed turn the screw in until the engine rolls slightly. Then turn it back, notch by notch, just to the point where the engine runs smoothly. When the engine is running properly there should be a steady hiss in the carburetor. On the average car the correct adjustment will be approximately 1½ turns out from the closed position.

If the engine idles too fast or too slow, loosen the lock screw and turn the small throttle stop screw (Fig. 5, Illus. No. 78) to the left or right until the proper speed is reached.

10-E—Starting and Warming Up Engine

First open the butterfly valve slightly by means of the hand throttle lever on the steering wheel; then pull the choke button out all the way if the engine is cold, turn the ignition switch to the "on" position and depress the starter switch. *The above instructions apply only to Special Six cars.* See page 50 for instructions on the Big Six.

As soon as the engine starts, push the choke button in about one-third of the way or to the point where the engine runs smoothly. Do not leave the choke button pulled out fully after the engine starts as this will flood the engine with gasoline and cause it to stop. As the engine warms up, the choke button should be pushed in gradually, the normal running position being all the way in. It must be remembered that the choke button should be out the shortest length of time possible, as running with a rich mixture tends to foul the spark plugs, dilute the lubricating oil and use an excessive amount of fuel.

The engine should start with not more than five or ten seconds cranking. If it does not do so, it may be that the choke valve does not entirely close, in which case loosen the choke lever clamping screw and reset the lever on the shaft so there is a clearance of 1/32 of an inch between the choke lever and the stop on the choke tube holder. Make sure that the valve is completely closed when setting the level by opening the air temperature regulating sleeve (Fig. 4, Illus. No. 78) and observing the position of the valve. On cars equipped with air cleaners the open position is indicated

The normal position of the air temperature regulating sleeve is closed. Only in extremely hot weather is it desirable to have it open.

11-E—Float Level

High Level. A high level will be caused by a leaky float valve brought about by an obstruction under the needle, a poor seat, a bent stem, a leaky or heavy float, or improper adjustment of the float level.

A high level will be indicated by a steady dripping of gasoline and the inability to obtain proper adjustments.

Low Level. A low level is caused by improper adjustment of the needle valve.

A low level will be indicated by failure of the engine to idle or to accelerate from low speed properly, hard starting and inability to properly adjust the carburetor for a mixture sufficiently rich.

12-E—Leaky Float Valve

A leaky float valve will be indicated by continual dripping of gasoline from the carburetor, although too high a float level will also cause this same condition.

There will naturally be a small amount of gasoline drip from the carburetor at the time of stopping the engine, due to the condensation of gas in the intake manifold, from where it runs back through the carburetor main air passage.

A leaky float valve may be caused by a worn needle or seat, sediment under the needle or a bent needle.

If the needle or seat are worn or if the needle is bent it will be necessary to make replacements. (See Operation Article No. 49).

If sediment is under the needle, remove the needle and float cover assembly and blow out the dirt. (See "Cleaning Carburetor," Operation Article No. 51).

STROMBERG CARBURETOR
(Models OX and TX-2)

6-E-1—Operation

Stromberg Carburetor Model OX, was used on a few of the first Big Six Commander Models built. The construction, operation and adjustment of this carburetor is practically the same as for the Model LS-2 used on the Special Six and described under the original Stromberg Carburetor Article.

Stromberg Carburetor Model TX-2, now used in production on the Big Six Commander Models, is a plain tube carburetor containing the following special features:

A gasoline feed above the throttle, with separate adjustment for idling the engine.

An accelerating well, which gives an extra supply of fuel for a moment as the throttle is opened.

An economizer, which permits the carburetor to operate on a very lean and economical mixture at the closed throttle position of average driving, but automatically shifts to the richer setting when the full power of the engine is called for.

A limited high speed adjustment.

A new type of warming up control, which gives improved starting ability and unusually smooth operation after starting while the engine is cold.

See paragraph 7-E before attempting to adjust the carburetor.

8-E-1—High Speed Adjustment

Turning the high speed adjusting screw (Fig. 4, Illus. No. 91) OUT gives a richer mixture and IN a leaner one. These carburetors now have a cap on the adjusting screw head which allows the needle to be turned only one half turn richer or leaner from the halfway point (Marked with an arrow, see "K", Illus. No. 94) until the stop on the cap comes into contact with a small bracket on the carburetor body. (See Illus. No. 93). If, for any reason the high speed adjusting screw has been removed, an approximate adjustment can be made by turning the needle out 3 turns off its seat, when the arrow on the cap should point to the projection on the float chamber cover.

With the engine running at a speed corresponding to 25 miles per hour, turn the needle to the right or in, a notch at a time until the engine runs unevenly. Then turn the needle back until the engine runs steadily.

This adjustment will give the leanest possible mixture for satisfactory performance. The setting may vary slightly, depending on the temperature, altitude and condition of the engine.

If the one turn of adjustment provided for does not give satisfactory engine performance, do not remove the stop bracket, but first check carefully the points given in Article 7-E.

9-E-1—Idling Adjustment

Turning the idling adjusting screw (Fig. 4, Illus. No. 91) IN gives a richer mixture and OUT a leaner one.

With the idling adjusting screw turned out 1½ turns off its seat, start the engine and with the throttle closed turn the screw in until the engine rolls slightly. Then turn it back, notch by notch, just to the point where the engine runs smoothly. When the engine is running properly there should be a steady hiss in the carburetor. On the average car the correct adjustment will be approximately 1 turn out from the closed position.

If the engine idles too fast or too slow, loosen the lock screw and turn the small throttle stop screw (Fig. 3, Illus. No. 91) to the left or right until the proper speed is reached.

10-E-1—Starting and Warming Up Engine

Open the throttle slightly with the lever on the steering wheel, pull out the choke button about 3/8 of an inch in the warm weather or all the way out in cold weather, turn on the ignition switch and depress the starter button.

As soon as the engine starts the choke button can be regulated until the engine warms up. All the way out, the choke valve in the carburetor is closed and the auxiliary control needle is raised off of its seat (See Illus. No. 92) as the choke button is pushed in the auxiliary needle is lowered until it becomes seated when the choke button is all the way in.

This auxiliary control needle enriches the mixture and can be used while the engine is warming up by having the choke button out 1/8 to 1/4 of an inch, but should be used as short a time as possible, the choke button being pushed all the way in for normal driving.

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Never grind the needle or the needle valve seat. The needle or needle valve seat should never be ground in an attempt to obtain a good seat, as it is impossible to grind a seat that will hold gasoline.

In case of a leak at the needle valve due to an improper seat, remove the needle valve cap and turn the needle against the seat with the fingers, tapping the needle lightly and making sure not to spring it. While turning and tapping the needle make sure to have the float chamber full of gasoline so that the needle will be held in the correct position.

13-E—Leaky Float

In case of a leaky float it is advisable to replace it with a new one. If the float is repaired by soldering, there is danger of making it too heavy.

Float Level Adjustment. To check the float level needle valve cap and measure the travel of the needle between the open and closed positions. This should be 5/64 of an inch.

To adjust the float level loosen lock nut "B", hold guide sleeve "A" and adjust the needle with a screw driver as shown in Illus. No. 84.

Tighten the lock nut and again check the lift of the needle.

14-E—Setting Economizer Needle

The Economizer Needle (Fig. 2, Illus. No. 78) should be set so that it is lifted ¼ of an inch off the seat when the throttle valve is closed.

This adjustment can be obtained by screwing the adjusting nut up or down and locking it with a split pin in the correct position.

The economizer needle should pull off the seat easily and snap down on the seat when released. If it should bind remove the economizer needle assembly by unscrewing needle valve sleeve "N" (Illus. No. 86) and taking off adjusting nut "M". Inspect the needle for straightness.

15-E—Setting Butterfly Valve

If the throttle valve has been removed, assemble it with the arrow (or mark) stamped on the valve, as shown in Illus. No. 82, pointing to idling discharge jet "A" when in the closed position.

BALL AND BALL CARBURETOR

Previous to Car Serial 2082183.

16-E—Operation

The Ball and Ball carburetor used on the Big Six previous to car serial 2082183, is a two stage carburetor. The first and second stage throats are plainly shown in Fig. 2, Illus. No. 76.

Through a given range of throttle opening all the gas is drawn down through the first stage throat (Illus. No. 76). The capacity of the first stage is sufficient to take care of all level road speeds up to approximately forty or forty-five miles per hour. Fig. 4 shows clearly how the second stage is brought into action by opening the main throttle to its extreme position. The cam arm, integral with the main throttle shaft, coming into contact with the roller on the arm of the second stage throttle shaft causes the second stage throttle to open under additional pressure. The resultant action is to draw an additional or secondary supply of gax mixture through the second stage throat (Fig. 2). Briefly speaking, the first stage furnishes all that is desired in what might be called the touring range, giving ideal economy and ample power for all ordinary purposes. The secondary stage supplies everything desired over and above the first stage in the form of added acceleration, power and speed.

In detail, the gasoline is fed into the float chamber through a removable cylindrical strainer (Fig. 1). From the float chamber the gasoline is fed separately to both first and second stage jets which are of the fixed orifice type. Referring to Fig. 1, the gasoline feeding to the first stage throat, after leaving the first stage jet, passes through a tube, adjustable in height, known as the "Idling Adjusting Screw." By raising this screw the idling mixture becomes leaner; by lowering the screw mitxure is made richer. *This is the only adjustment on the carburetor,* aside from the throttle stop screw.

The pick-up device consists of a spring-operated plunger pump (Fig. 1) which receives a supply of gasoline direct from the float chamber through

a small hole in the float chamber fastening bolt. The gasoline fills the pump chamber to the level of that in the float chamber. In opening the main throttle, the pick-up plunger is depressed. As the plunger is depressed, gasoline is forced out through holes in the plunger stem and is carried into the main air chamber of the carburetor (through a passage from the pick-up pump (Fig. 2), along with air drawn through the ports at the top and side wall of the pump chamber. The resultant action is to supply the additional gasoline required for acceleration. The construction, on account of the time required to fill the pump, is such that the engine cannot be flooded by repeated opening and closing of the throttle.

The idling by-pass (Fig. 2) consists of a tube through which a sufficient amount of gas mixture is taken in above the throttle valve to keep the engine running when the throttle is closed.

The choke valve is located below the first stage throat and is for the purpose of enriching the mixture when starting.

17-E—Adjustments

Prior to making any carburetor adjustment, the following points should be thoroughly covered:

1. See that the spark plug points are spaced to .025 of an inch.
2. See that the breaker points are set to .020 of an inch.
3. See that the cylinders have good compression. It may be that some of the tappets are holding the valves partly open. These should all be gone over as outlined under Operation Article No. 6.
4. The engine should be warmed up to the normal running temperature before making any adjustments.

The only adjustment is the idling adjustment previously explained. This produces no effect whatever on the running of the car except when the throttle is closed to the idling position. The richness of mixture at all speeds, above idling, is determined by fixed first and second stage jets. (See Fig. 4, Illus. No. 76).

The first stage (primary) jet as furnished in the car is No. 100 and the second stage (secondary) jet is No. 140. These sizes will take care of all ordinary requirements.

Smaller first stage jets No. 95 or No. 90 and smaller second stage jets No. 135 or No. 130 may give better results in hot climates, extremely warm weather, or in high altitudes.

18-E—Starting and Warming Up Engine

To make starting easy with the Ball and Ball Carburetor, first close the throttle valve (*throttle must be closed completely*), then pull the choke button all the way out. Turn the ignition switch to the "ON" position and depress the starter switch. *The above instructions apply only to Big Six cars.* See page 48 for instructions on the Special Six. As soon as the engine starts, speed it up slightly and push the choke button in gradually as the engine warms up. The normal running position of the choke button is all the way in. It must be remembered that the choke button should be out the shortest length of time possible, as running with a rich mixture tends to foul the spark plugs, dilute the lubricating oil, and use an excessive amount of fuel.

The engine should start with not more than five or ten seconds cranking. If it does not do so, it may be that the choke valve does not close completely. Remove the flexible air tube and examine the choke valve. If it does not close when the choke putton is pulled out all the way inspect the choke wire and tube connections.

19-E—Carburetor Leaks

Continual dripping of gasoline from the carburetor will be due to a worn float needle or seat, dirt under the needle, a leaky float, float level too high, a leak at primary throat gasket "A" (Illus. No. 76, Fig 2), or loose or broken external gaskets.

Dripping of gasoline from the carburetor for a short time only, after the engine is stopped, does not always indicate a leaky carburetor. This is a natural action due to condensation of gases in the manifold.

20-E—Float Level

A collar is sweated onto the float needle at the factory in the correct position to give the proper float level. Therefore, the adjustment can only be changed in case the collar has been moved on the stem.

A high level may be due to a leaky or heavy float, a leaky float valve due to dirt under the needle, a poor seat or a bent stem. A high level will be indicated by a steady dripping of gasoline and a rich mixture.

A low level will be due to the collar on the needle having been moved and will be indicated

13-E-1—Leaky Float

In case of a leaky float it is advisable to replace it with a new one. If the float is repaired by soldering, there is danger of making it too heavy.

Float Level Adjustment. To check the float level, remove the float chamber cover, hold the cover assembly in an inverted position and measure the distance between the float and the inner surface of the cover when the needle is seated. The distance should be 7/32 of an inch.

To adjust the float level, bend the float arm where it bends away from the float body. The float level can also be checked by removing the float chamber sight hole plug. The gasoline should just be up to the bottom edge of the sight hole.

14-E-1—Setting Economizer and Auxiliary Control Needles

The Economizer Needle (Illus. No. 92) should be set so that it is lifted 3/8 of an inch off of its seat when the throttle valve is closed.

The Auxiliary Control Needle (Illus. No. 92) should be set so that it is lifted 1/16 of an inch off its seat when the choke button is pulled all of the way out.

These adjustments can be obtained by screwing the adjusting nut up or down and locking it with a split pin in the correct position.

The needle should pull off its seat easily and snap down on the seat when released. If it should bind, remove the needle by turning out the screws holding the carburetor throttle valve body to the main body and lifting it off.

The Needles can then be removed by unscrewing the adjusting nuts. Inspect the needle for straightness.

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by the engine failing to idle or to accelerate from low speed properly, hard starting, and a lean mixture.

21-E—Leaky Float Valve

A leaky float valve will be indicated by continual dripping of gasoline from the carburetor, although a leak at the first stage (primary) throat or too high a gasoline level will cause the same condition. A leaky float valve will be caused by a worn needle or seat, sediment under the needle, or a bent stem. Always remove the needle and cover assembly in case of a leak and inspect the needle to see if it is clean and seating properly. Then blow out the dirt.

Extreme caution should be used in removing the needle and cover to see that the needle is not bent. Push the float down with the finger after the cover is lifted slightly, so the needle can be lifted out without binding on the float.

If the needle or seat are worn, it is advisable to replace the entire float chamber cover and needle assembly, as the collar is set on the stem at the factory to give the proper float level. To replace the needle only, melt the solder around the collar on the needle stem and install a new needle. To set the collar to give the proper float level see "Checking Float Level." *Never grind needle or needle valve seat.*

22-E—Leaky Float

In case of a leaky float it is advisable to install a new float as there is danger of making it too heavy if the leak is repaired by soldering.

23-E—Leak at First Stage (Primary) Throat

The first stage throat (Illus. No. 76, Fig. 2) is screwed into the body of the carburetor with a thin gasket at the seat as shown at "A". This gasket sometimes dries out and cracks or the throat becomes loose, causing a steady slow leak. Remove the first stage intake opening (Fig. 4) by loosening set screw "B". To tighten or remove the throat use a wrench made of a flat piece of steel 1⅜ inch wide by 3/32 of an inch thick and about 4 inches long. It is advisable always to install a new gasket instead of trying to overcome the leak by tightening the throat.

24-E—Checking Float Level

To check the float level, remove the needle dust cap and with the needle pushed down scribe the needle as in Illus No. 77, Fig. 1. With the needle and cover assembly removed as in Fig. 2, move the needle so it is in the same position as when scribed. When held in this position (as in Fig. 3) the two arms will be approximately horizontal if the collar is placed to give the correct float level. In case a new needle is installed at any time, the above procedure should be followed to find the correct position for the collar on the needle.

25-E—Carburetor Dirty

Any dirt which may get through the screen in the top of the vacuum tank (Illus. No. 69) is usually caught by the screen at the carburetor (Fig. 1, Illus. No. 76). However, after long usage some of the passageways in the carburetor may become clogged by an accumulation of fine particles that get past all strainers. To clean the carburetor, see Operation Article No. 52.

BALL AND BALL CARBURETOR, MODEL SV-33

(*After car serial* 2082183).

26-E—Operation

The principal features of the model SV-33, used on Big Six cars after serial number 2082183, are an automatic choke valve, a more effective idling adjustment and summer and winter primary metering screws.

The two-stage feature is retained, similar in operation to the prevous carburetor with its primary and secondary stage, controlled by separate butterfly valves (Illus. No. 75) and fed by separate metering screws. The primary stage is designed to give maximum performance and economy at ordinary driving speeds while the secondary stage, which is cut in at about 45 miles per hour, is adjusted for maximum power at the higher speeds.

27-E—Choke Valve

The choke mechanism consists principally of a choke blade, choke blade arm, choke blade reed and choke spring assembled as shown in Fig. 1, Illus. No. 70.

The purpose of this arrangement is to vary automatically, the warming up mixture for different engine speeds and still permit normal use of the choke in starting.

When in the fully closed position (See Illus. No. 70) with the choke button pulled clear out, the air inlet of the carburetor is entirely closed. By pushing the choke button in about one-fourth of the way the "Automatic choke" position is reached. In this position the amount of air passing the valve is controlled by the flexible choke blade reed. At idling speeds this reed is closed and the hole through it passes the correct amount of air.

As the engine speed increases the reed is gradually opened by the air current and admits more air, thereby changing the mixture to suit the operating conditions.

After the engine is warmed up and the choke button is pushed clear in, the valve is wide open and in-operative (Illus. No. 7).

28-E—Starting the Engine

Open the throttle about one-fourth of the way by means of the throttle lever and leave it in this position until the engine is started. (Note that this is contrary to instructions on the previous Big Six carburetor with which it was necessary to have the throttle fully closed until the engine starts after which it should be opened enough to keep the engine running).

Pull the choke all the way out.

Keeping the hand on the choke button, press the starter pedal.

The instant the engine fires, push the choke in to the automatic choke position. This can be determined by pushing the button in a little too far and then pulling it back until the added tension of the choke blade spring is felt.

Retard the throttle so the engine is not racing.

After the engine is warmed up the choke button should be pushed clear in.

29-E—Idling Adjustment

Prior to making any carburetor adjustment, the following points should be thoroughly covered:

1. See that the spark plug points are spaced to .025 of an inch.

2. See that the breaker points are set to .020 of an inch.

3. See that all cylinders have good compression. It may be that some of the tappets are holding the valves partly open. These should all be gone over as outlined under Operation Article No. 6.

4. The engine should be warmed up to the normal running temperature before making any adjustments.

Turning the idling adjusting screw (Fig. 1, Illus. No. 75) in gives a richer mixture and out a leaner one.

First turn the idling adjusting screw all the way in and then back one-half turn.

Start the engine and with the throttle closed turn the screw out further until the engine slows down. Then turn it back notch by notch, just to the point where the engine runs smoothly. On the average car the correct adjustment will be approximately three-fourths of a turn out from the closed position.

Care should be taken not to make the idling adjustment too lean. If desired, however, it can be put a notch or two on the rich side.

If the engine idles too fast or too slow, loosen the lock screw and turn the small throttle stop screw to the left or right until the proper speed is reached.

30-E—Summer and Winter Setting

There are no adjustments on the carburetor, other than the idling adjustment described above, which affects the running of the engine only at idling speeds.

However, on the model SV-33 provision is made for a summer and winter setting. An extra primary metering screw (Illus. No. 74) is carried in a lug over the primary air horn. This screw and the primary metering screw, the location of which is shown in Illus. No. 73, are interchangeable, the one with the smaller orifice being for summer use and the other for winter use.

The size of the orifice is stamped on the head of the screw in hundredths of a millimeter, the larger number representing the larger orifice.

31-E—Automatic Economizer

The automatic economizer causes the carburetor to deliver a lean mixture giving maximum economy when running steadily at constant speeds and a rich mixture giving maximum power when accelerating or pulling hard.

The manifold vacuum above the throttle acts upon the step-up plunger (Fig. 2, Illus. No. 75) holding it up against the seat. When the manifold vacuum is high as when the engine operates at constant speeds, the plunger is held up as shown, and the low check valve is closed, causing the primary nozzle to receive fuel through the primary metering screw only.

If the manifold vacuum is low as when the engine is accelerating or pulling hard, the plunger is released and, being forced down by the spring, opens the lower valve. Then, fuel flows to the primary nozzle through the step-up passages as well as through the primary metering screw, enriching the mixture to give maximum power.

32-E—Float Level

The fuel level in the float chamber may be observed by removing the step-up metering screw (Fig. 2, Illus. No. 75). With the engine running, the level in the well should stand between the center and the top of the horizontal passage (Fig. 2, Illus. No. 75).

When the engine is not running, the level may be slightly higher.

A collar is sweated onto the float needle at the factory in the correct position to give the proper float level. Therefore, the adjustment can only be changed in case the collar has been moved on the stem.

A high level may be due to a leaky or heavy float, a leaky float valve due to dirt under the needle, a poor seat or a bent stem. A high level will be indicated by a steady dripping of gasoline and a rich mixture.

A low level may be due to the collar on the needle having been moved and will be indicated by the engine failing to idle or to accelerate from low speed properly, hard starting and a lean mixture.

33-E—Cleaning Carburetor

Any dirt which may get through the screen in the tip of the vacuum tank is usually caught by the gasoline filter or the screen at the carburetor. However, after long usage some of the passage ways may become clogged by an accumulation of fine particles that get past all strainers. Refer to Operation Article No. 53 if necessary to clean the carburetor.

TOLERANCE CHART

The chart on the following page is for your convenience in repair work. It will give you definite information as to the serviceability of parts subject to wear and distortion.

Considerable judgment must be exercised in its use, however, and any decision based on this data must be tempered by individual conditions and the wishes of the car owner.

For example, the maximum piston clearance is given at .007 of an inch. This means that, when overhauling the engine to put it in first class condition, pistons having clearance up to this amount may be considered serviceable, while those with greater clearance must be replaced to obtain a first class job. However, this is not to be interpreted as meaning that a piston having clearance is totally unfit for service. The thoroughness of overhaul as specified by the owner should determine this.

	Tolerance For New Parts		Tolerance For Parts In Service
	MIN.	MAX.	MAX.
Crankshaft			
Crankshaft journal roundness	.000″	.001″	.004″
Crankshaft journal taper	.000″	.001″	.004″
(The tolerance given under "New Parts" for the above two items apply to reconditioned journals)			
Crankshaft alignment	.000″	.002″	.004″
Crankshaft bearing clearance	.0015″	.002″	.005″
Crankshaft end play	.002″	.004″	.012″
Connecting Rod			
Twist	.000″	.002″	.003″
Bend	.000″	.002″	.003″
Bearing clearance	.0015″	.002″	.005″
Bearing side play	.004″	.007″	.012″
Piston			
Clearance (Special Six)	.0035″	.004″	.006″
Clearance (Big Six)	.004″	.0045″	.007″
Roundness	.000″	.002″	.002″
Taper	.000″	.002″	.002″
Squareness of bore for piston pin	.000″	.003″	.003″
Piston Pin			
Roundness	——	——	.003″
Clearance in bushing	.0005″	.001″	.004″
Piston Ring			
Roundness	——	——	.002″
Gap	.012″	.022″	.028″
Clearance in groove	——	——	.003″
Tension (Big Six) (Plain and oil seal rings)	8 lbs.	11 lbs.	8 lbs. min.
Tension (Special Six) (Plain and oil seal rings)	7 lbs.	10 lbs.	7 lbs. min.
Tension (Big Six) (Perfect circle rings)	8½ lbs.	10½ lbs.	8½ lbs. min.
Tension (Special Six) (Perfect circle rings)	7½ lbs.	9½ lbs.	7½ lbs. min.
Cylinder Wall			
(Tolerances given under "New Parts" are for reconditioned cylinders)			
Roundness	.000″	.002″	.003″
Taper	.000″	.002″	.003″
Valves			
Alignment of stem	——	——	.0015″
Valve stem clearance			
Intake	.001″	.003″	.004″
Exhaust	.002″	.004″	.004″
Push rod clearance (in guide)	.0005″	.001″	.003″
Tappet clearance—Intake and Exhaust (hot)			
Passenger cars	.006	.006	.006″
Busses (Intake)	.006″	.006″	.006″
Busses (Exhaust)	.010	.010	.010″
Valve spring tension			
(When compressed to 1 13/16″)	45 lbs.	50 lbs.	40 lbs. min.
(When compresesd to 1 13/16″) (after engine No. EW 717 & ES 56,916)	55 lbs.	60 lbs.	50 lbs. min.

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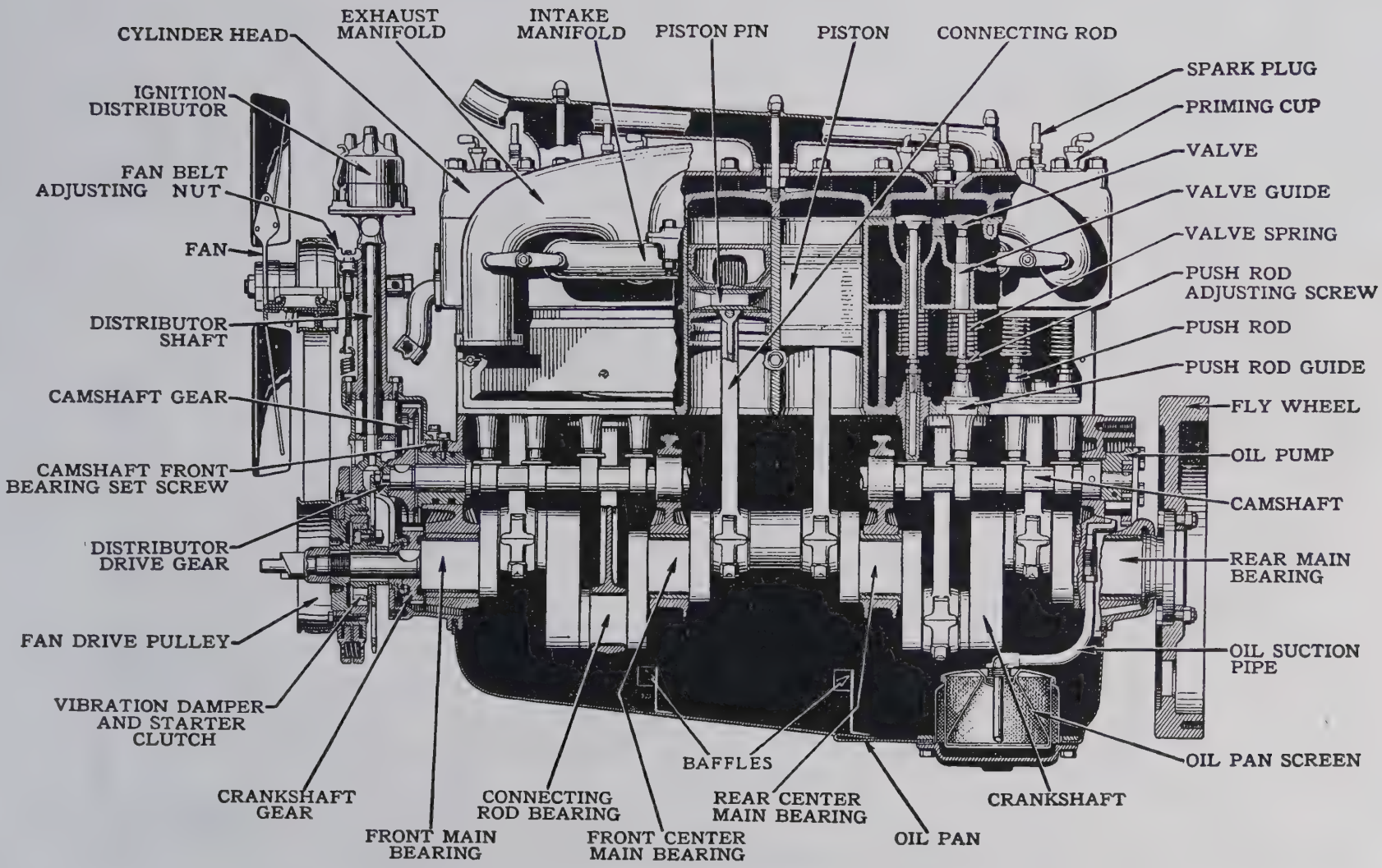
	Tolerance For New Parts		Tolerance For Parts In Service
Timing Gears			
Clearance between teeth	.001″	.003″	.012″
Water Pump Shaft			
Roundness	——	——	.003″
End play	.0005″	1/64″	*——
Alignment	——	——	.002″
Clearance in bushing	.0005″	.0025″	.004″
Generator Drive Shaft			
Roundness	——	——	.003″
Alignment	——	——	.002″
Clearance in bushing	.0005″	.0025″	.005″
Camshaft			
Endplay	.0005″	.006″	.010″
Bearing roundness	——	——	.004″
Clearance in front bearing	.0015″	.003″	.006″

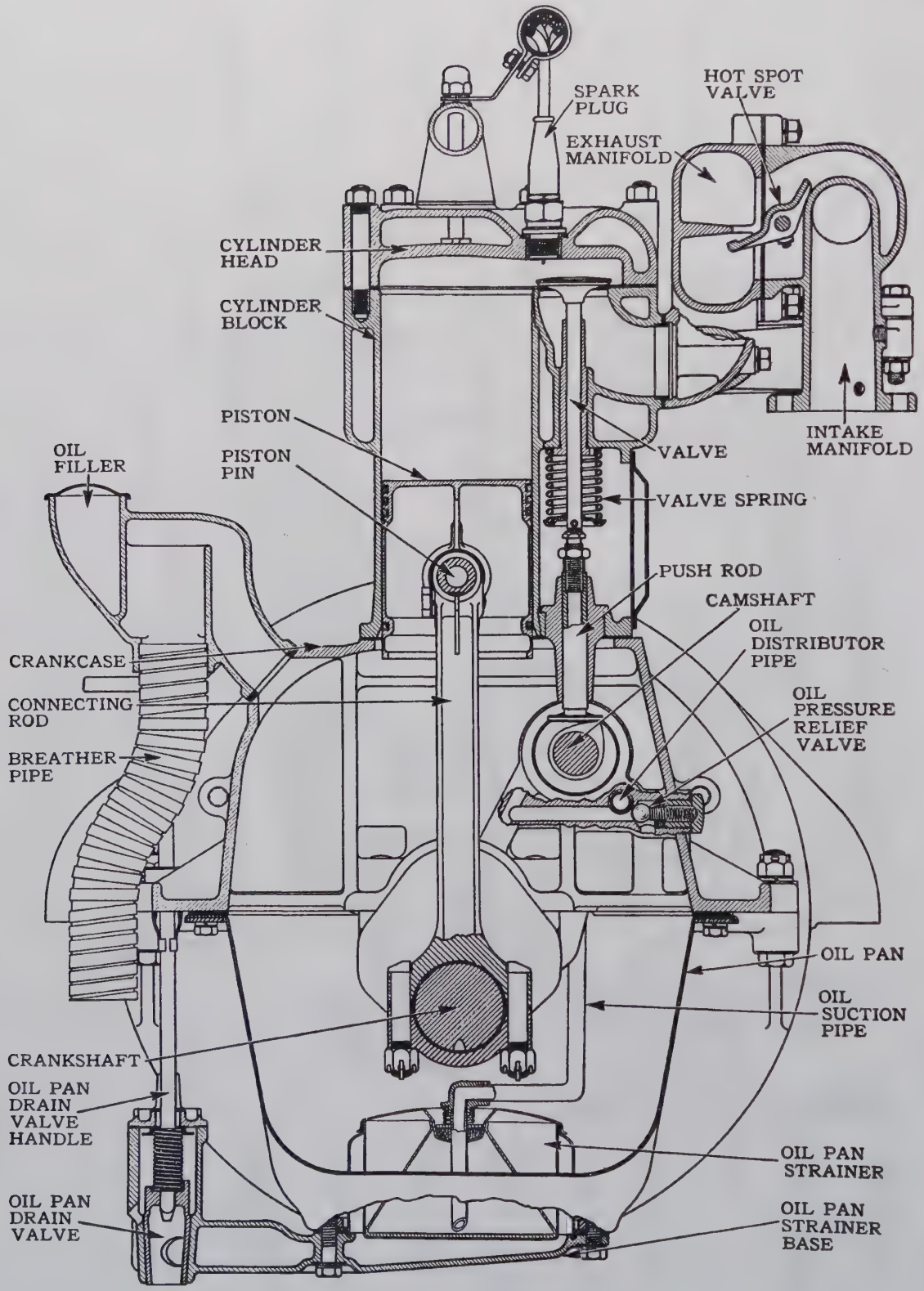
*** End play not of great importance as long as impeller does not strike pump housing.**

ILLUSTRATIONS



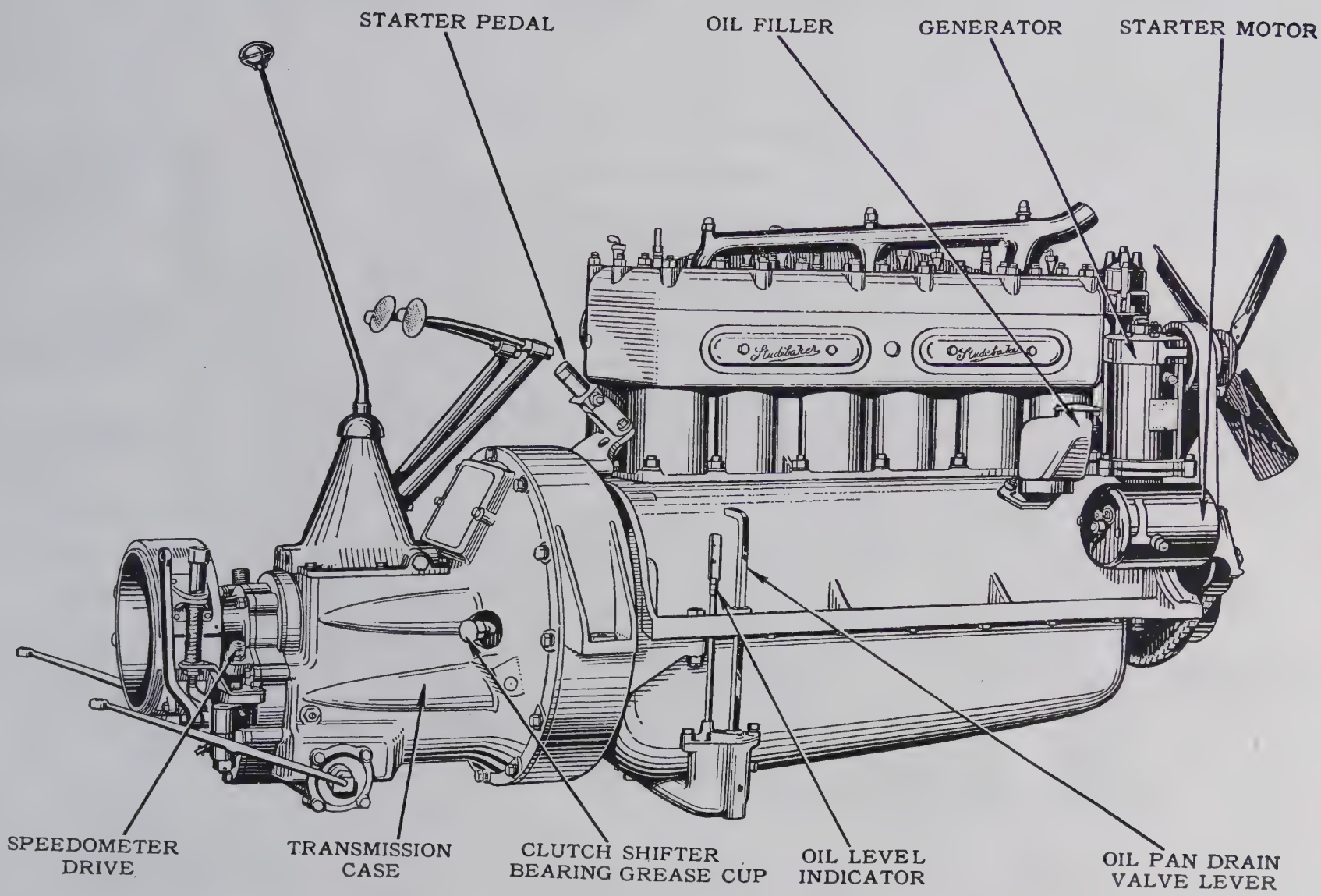
Illus. No. 1

Longitudinal Section Through Big Six Engine



Illus. No. 2

Cross Section of Engine

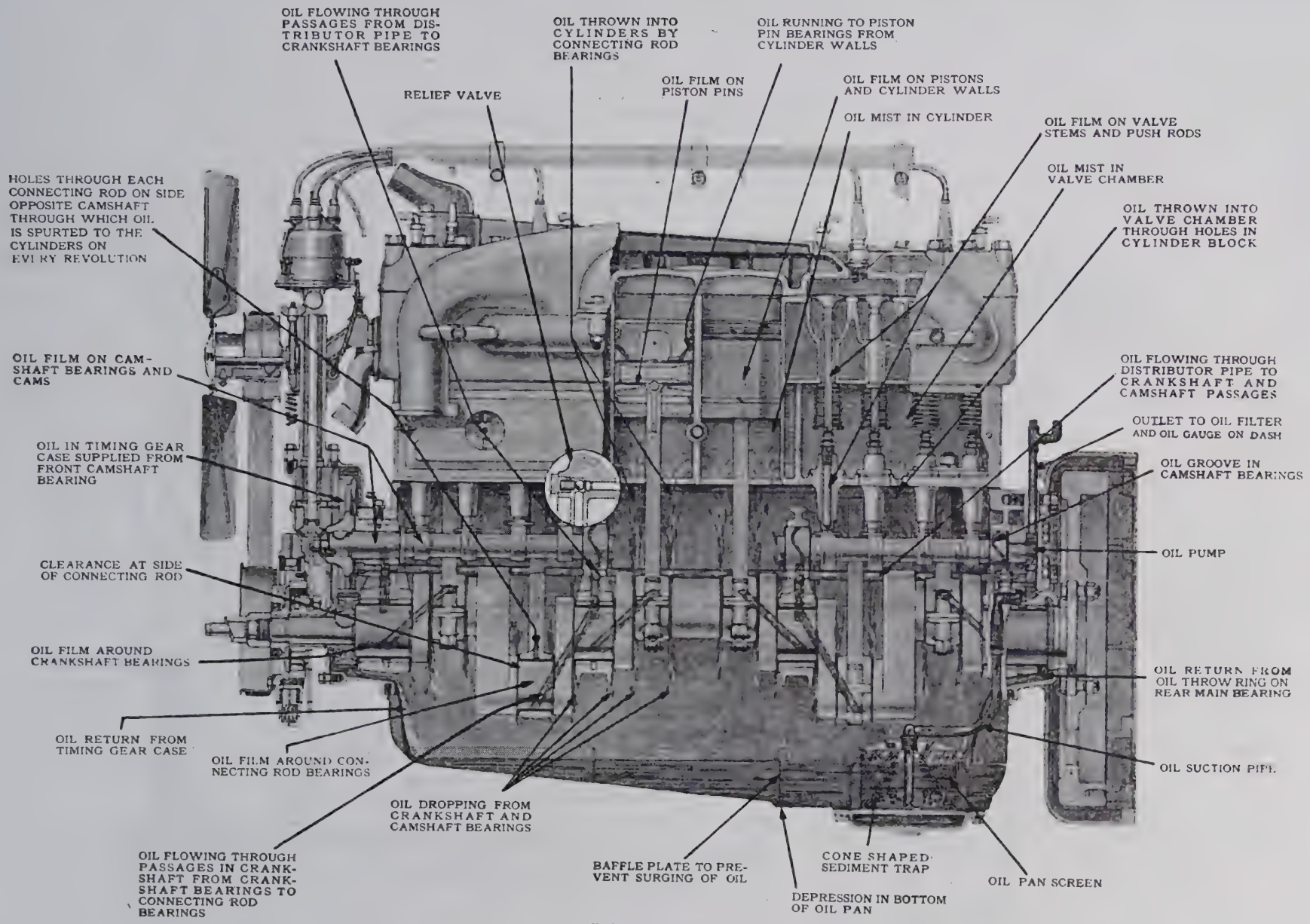


Illus. No. 3

Right Side of Big Six Engine

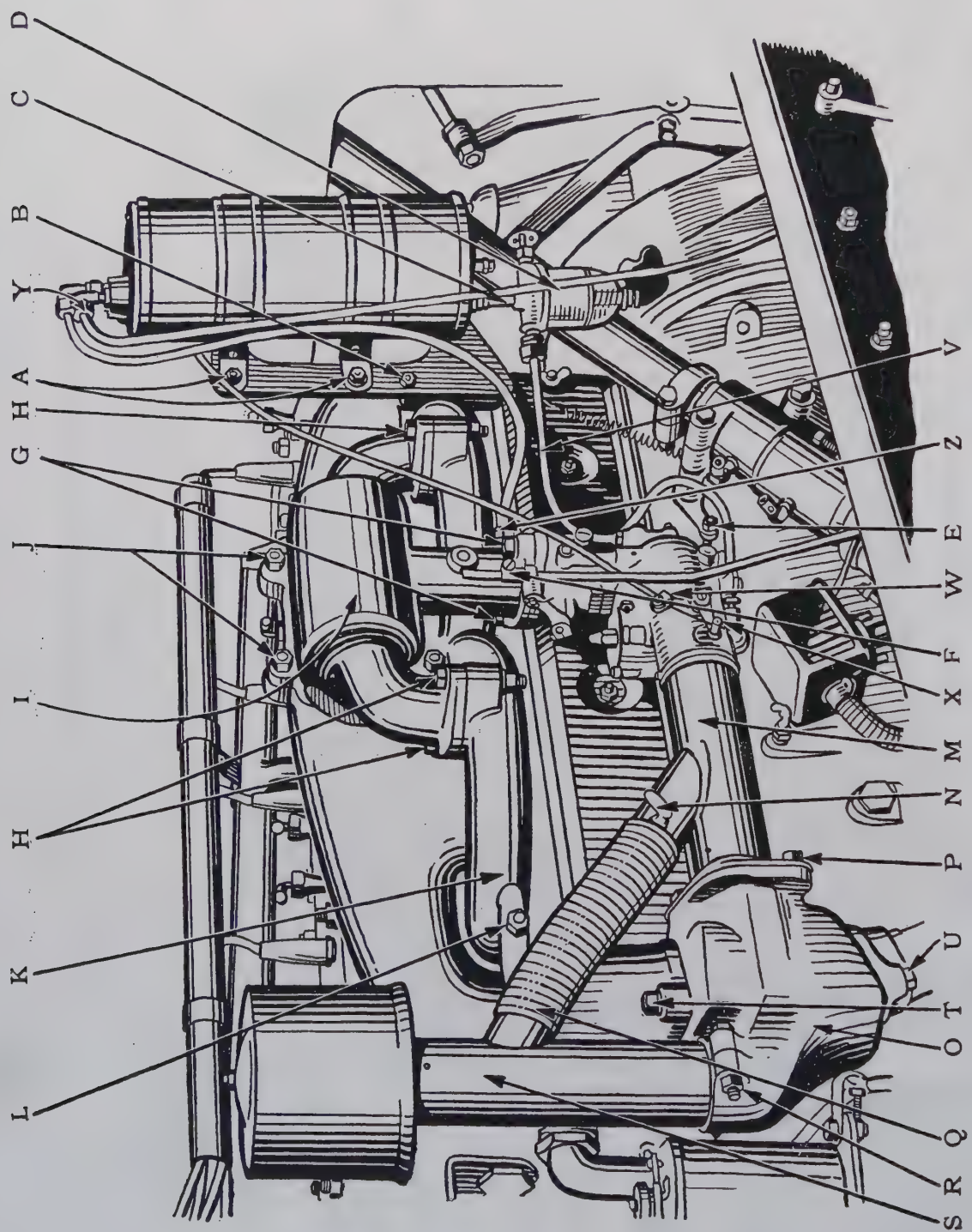
Illus. No. 4

Left Side of Big Six Engine


OIL FLOWING THROUGH PASSAGES FROM DISTRIBUTOR PIPE TO CRANKSHAFT BEARINGS
OIL THROWN INTO CYLINDERS BY CONNECTING ROD BEARINGS
OIL RUNNING TO PISTON PIN BEARINGS FROM CYLINDER WALLS
RELIEF VALVE
OIL FILM ON PISTON PINS
OIL FILM ON PISTONS AND CYLINDER WALLS
OIL MIST IN CYLINDER
OIL FILM ON VALVE STEMS AND PUSH RODS
OIL MIST IN VALVE CHAMBER
OIL THROWN INTO VALVE CHAMBER THROUGH HOLES IN CYLINDER BLOCK
HOLES THROUGH EACH CONNECTING ROD ON SIDE OPPOSITE CAMSHAFT THROUGH WHICH OIL IS SPURTED TO THE CYLINDERS ON EVERY REVOLUTION
OIL FILM ON CAMSHAFT BEARINGS AND CAMS
OIL FLOWING THROUGH DISTRIBUTOR PIPE TO CRANKSHAFT AND CAMSHAFT PASSAGES
OUTLET TO OIL FILTER AND OIL GAUGE ON DASH
OIL IN TIMING GEAR CASE SUPPLIED FROM FRONT CAMSHAFT BEARING
OIL GROOVE IN CAMSHAFT BEARINGS
OIL PUMP
CLEARANCE AT SIDE OF CONNECTING ROD
OIL FILM AROUND CRANKSHAFT BEARINGS
OIL RETURN FROM OIL THROW RING ON REAR MAIN BEARING
OIL RETURN FROM TIMING GEAR CASE
OIL FILM AROUND CONNECTING ROD BEARINGS
OIL SUCTION PIPE
OIL DROPPING FROM CRANKSHAFT AND CAMSHAFT BEARINGS
OIL FLOWING THROUGH PASSAGES IN CRANKSHAFT FROM CRANKSHAFT BEARINGS TO CONNECTING ROD BEARINGS
BAFFLE PLATE TO PREVENT SURGING OF OIL
CONE SHAPED SEDIMENT TRAP
OIL PAN SCREEN
DEPRESSION IN BOTTOM OF OIL PAN

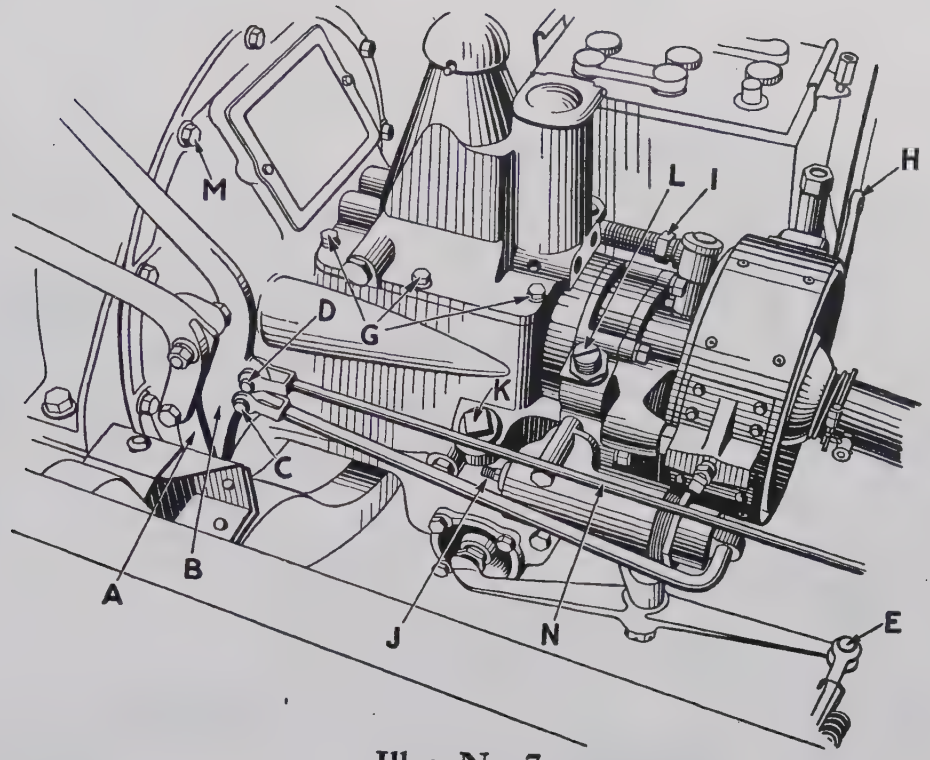
Illus. No. 5

Longitudinal Section Through Big Six Engine Showing Oiling System

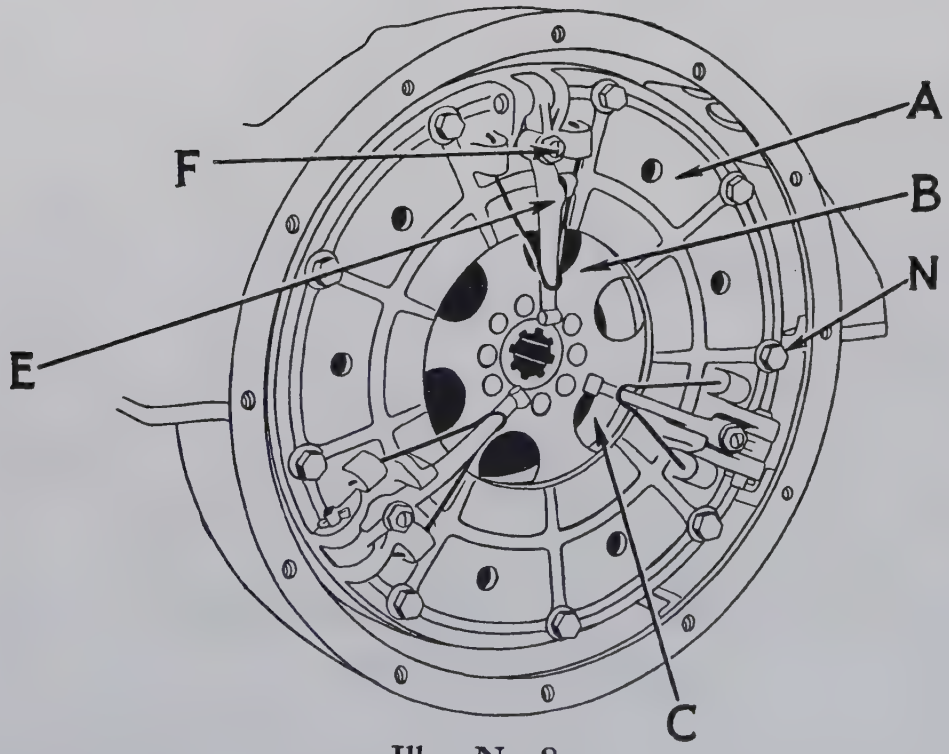


Illus. No. 6

Manifolds, Vacuum Tank and Carburetor Assembly



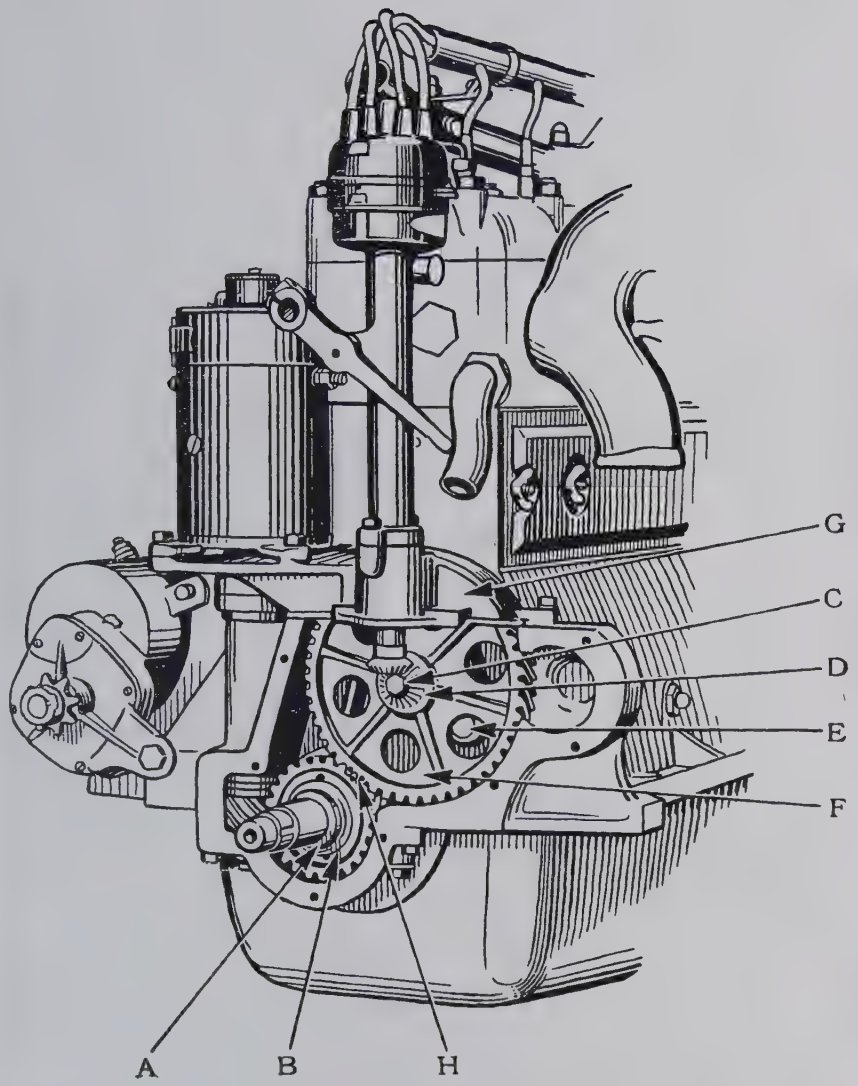
Illus. No. 7
Left-Hand Side of Transmission
Assembled in Chassis
(Hydraulic Brakes)



Illus. No. 8
Clutch Assembled in Flywheel

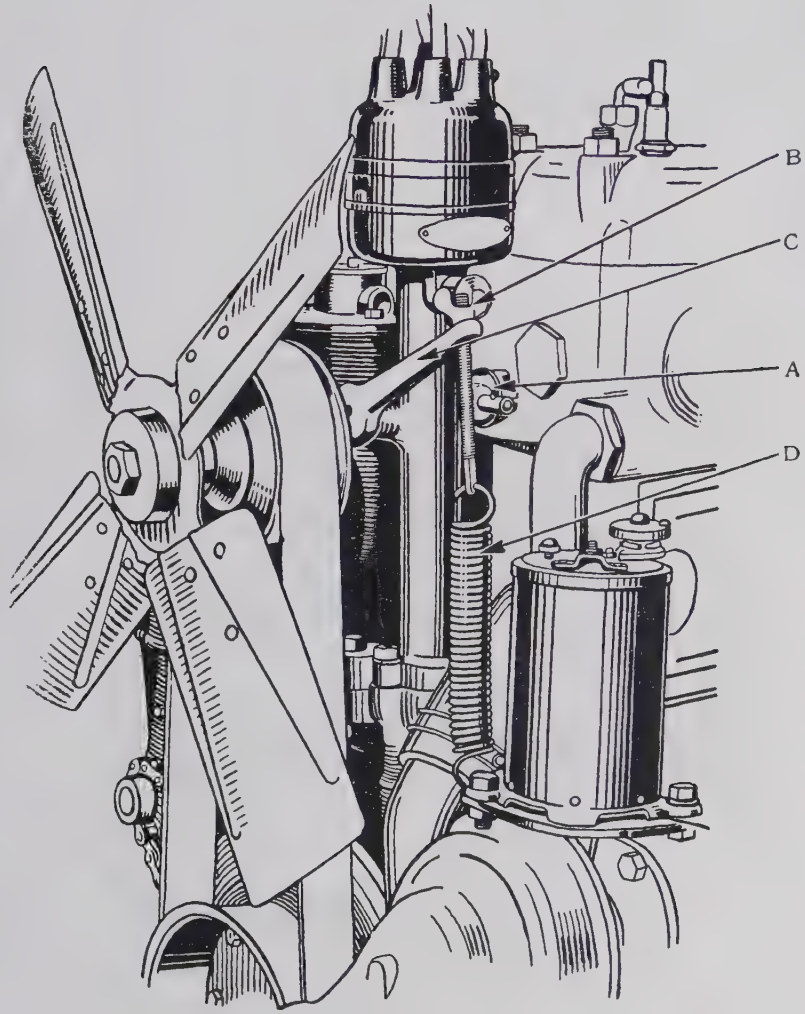
Illus. No. 10
Checking Distributor Gear Backlash

Illus. No. 9
Starting Motor, Generator and Distributor Assembled to Engine



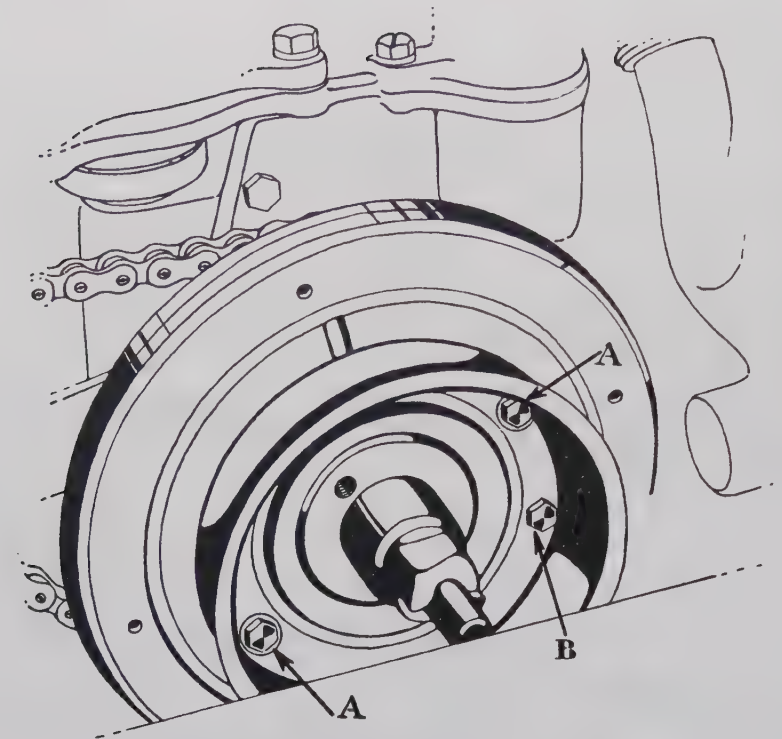
Illus. No. 11

Gear Case Front Cover and Water Pump Assembly Removed from Engine

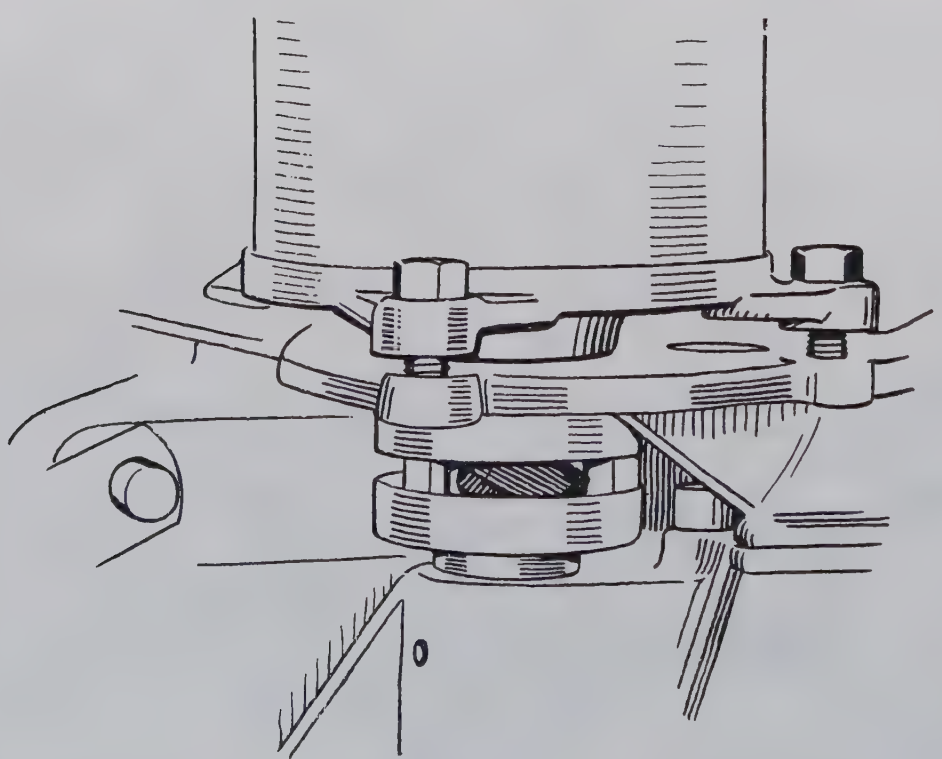


Illus. No. 12

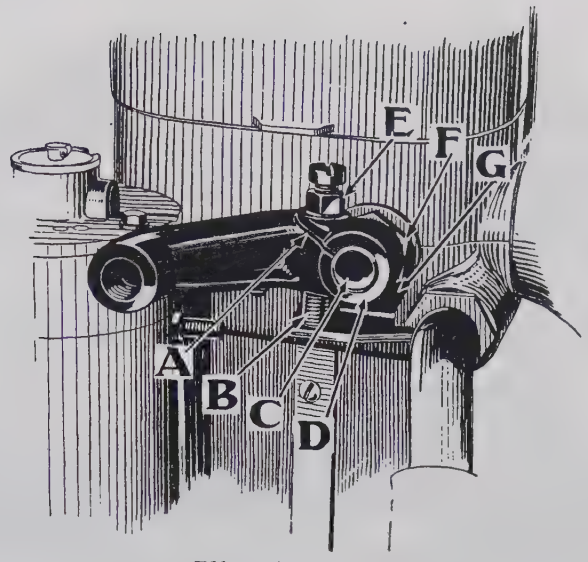
Self Adjusting Fan



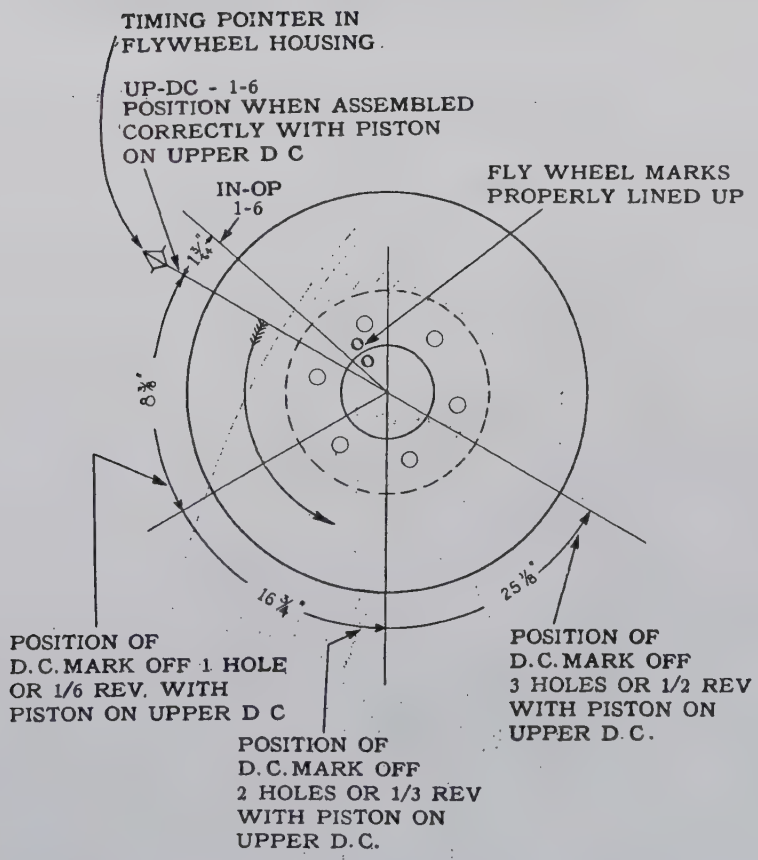
Illus. No. 13
Starter Clutch and Vibration Damper Mounted on Engine



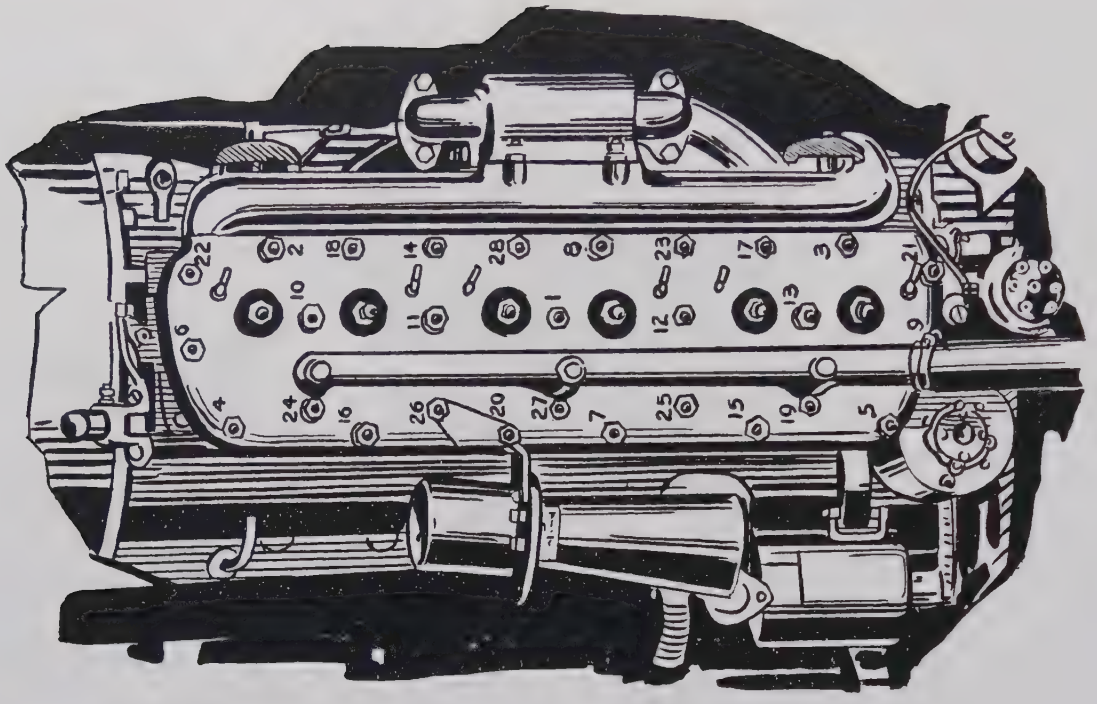
Illus. No. 14
Generator Coupling Rubber Bumpers Improperly Assembled



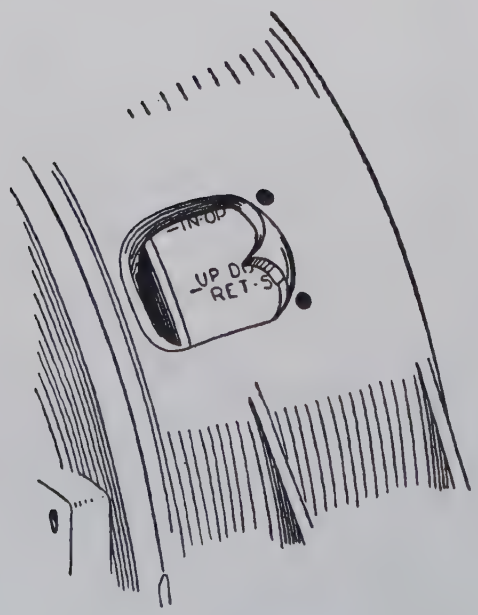
Illus. No. 15
Fan Bracket and Adjustments


TIMING POINTER IN FLYWHEEL HOUSING
UP-DC - 1-6 POSITION WHEN ASSEMBLED CORRECTLY WITH PISTON ON UPPER D C
IN-OP 1-6
FLY WHEEL MARKS PROPERLY LINED UP
13¾°
8⅜°
16¾°
25⅛°
POSITION OF D.C. MARK OFF 1 HOLE OR 1/6 REV. WITH PISTON ON UPPER D C
POSITION OF D.C. MARK OFF 2 HOLES OR 1/3 REV WITH PISTON ON UPPER D.C.
POSITION OF D.C. MARK OFF 3 HOLES OR 1/2 REV WITH PISTON ON UPPER D.C.

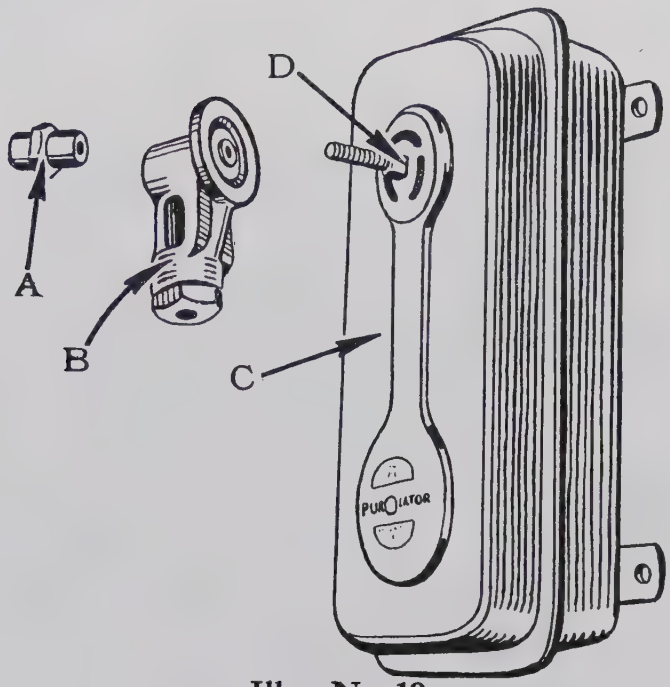
Illus. No. 16
Showing Position of Flywheel Marks When Improperly Assembled to Crankshaft Flange



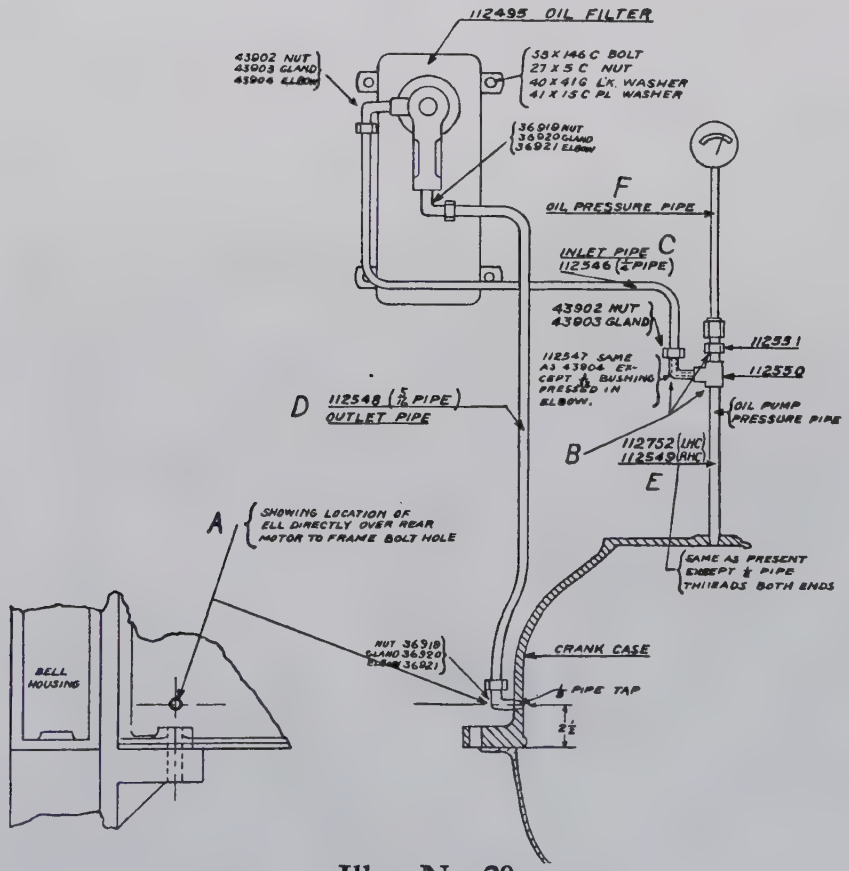
Illus. No. 17
Correct Order of Tightening Cylinder Head Nuts



Illus. No. 18
Flywheel Marks and Timing Hole



Illus. No. 19
Oil Filter Body and Sight Guage



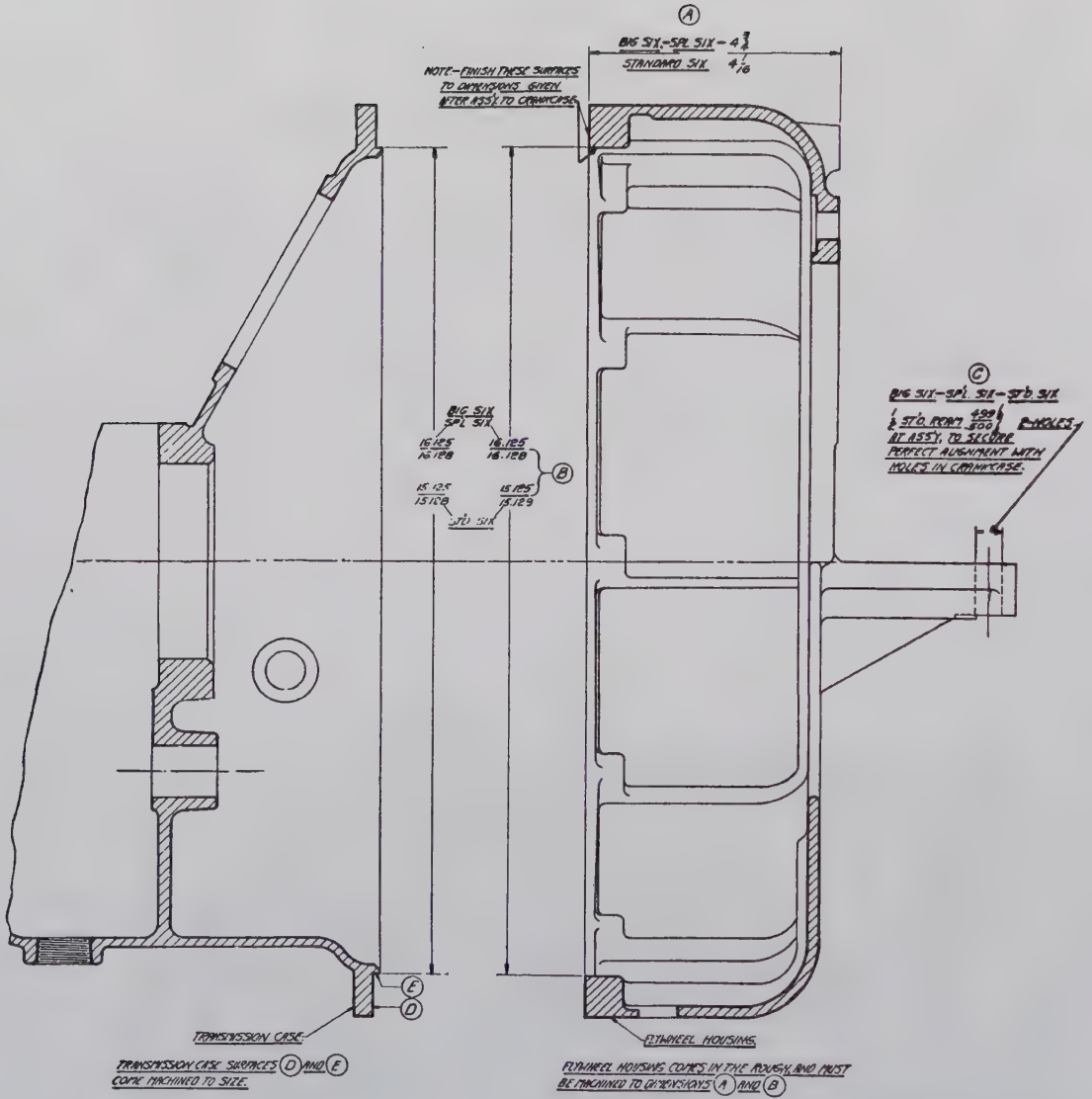
Illus. No. 20
Oil Filter Adaptation

Illus. No. 22
Machining Outer Face of Flywheel Housing

Illus. No. 21
Centering New Flywheel Housing Before Tightening Fastening Screws

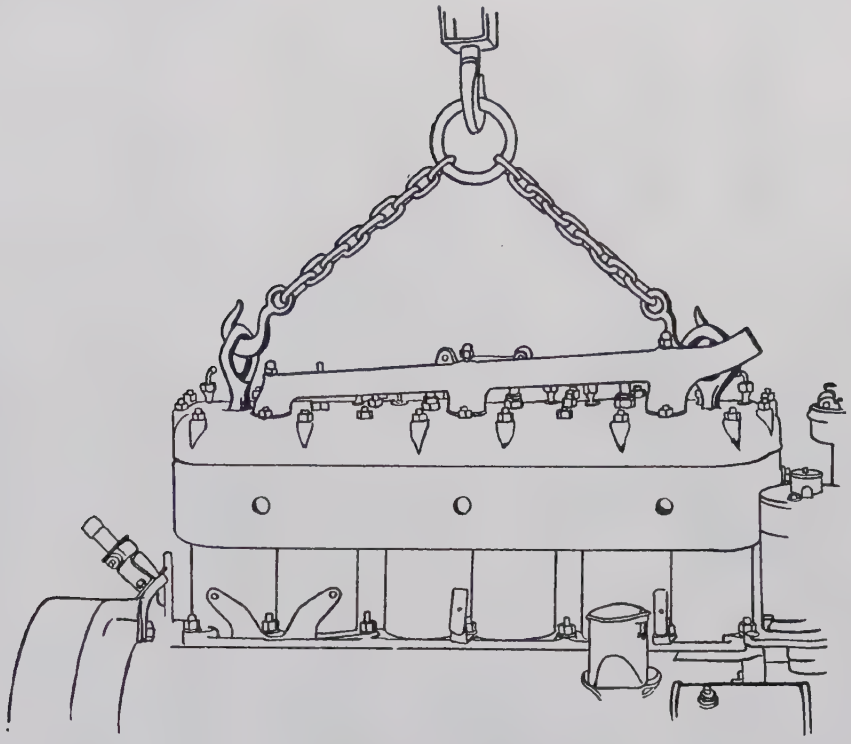
Illus. No. 24
Checking Outer Face of New Flywheel Housing After Machining

Illus. No. 23
Boring Inner Edge of New Flywheel Housing

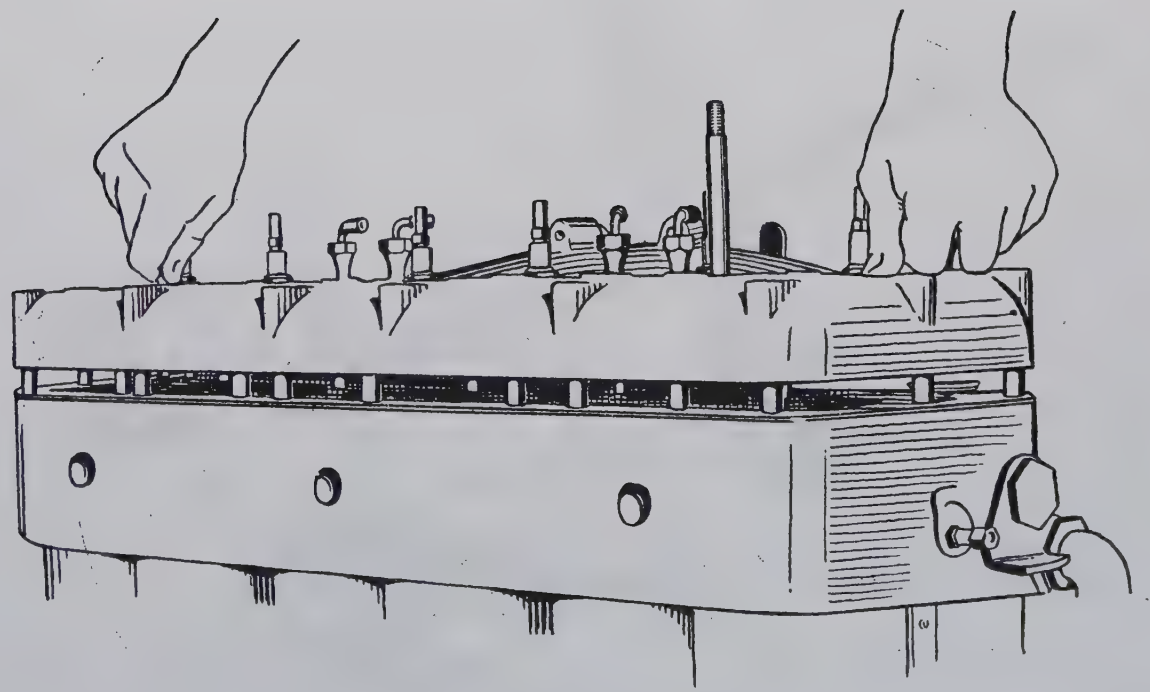

A
BIG SIX-SPL SIX - 4 3/4
STANDARD SIX 4 1/16
NOTE-FINISH THESE SURFACES TO DIMENSIONS GIVEN AFTER ASS'Y TO CRANKCASE.
BIG SIX SPL SIX
16.125 16.128
16.125 16.128
B
15.125 15.128
15.125 15.129
STD SIX
C
BIG SIX-SPL SIX-STD SIX
2 ST'D. REAM 499/500 DOWELS AT ASS'Y. TO SECURE PERFECT ALIGNMENT WITH HOLES IN CRANKCASE.
E
D
TRANSMISSION CASE
TRANSMISSION CASE SURFACES D AND E CODE MACHINED TO SIZE.
FLYWHEEL HOUSING
FLYWHEEL HOUSING COMES IN THE ROUGH AND MUST BE MACHINED TO DIMENSIONS A AND B

Illus. No. 25

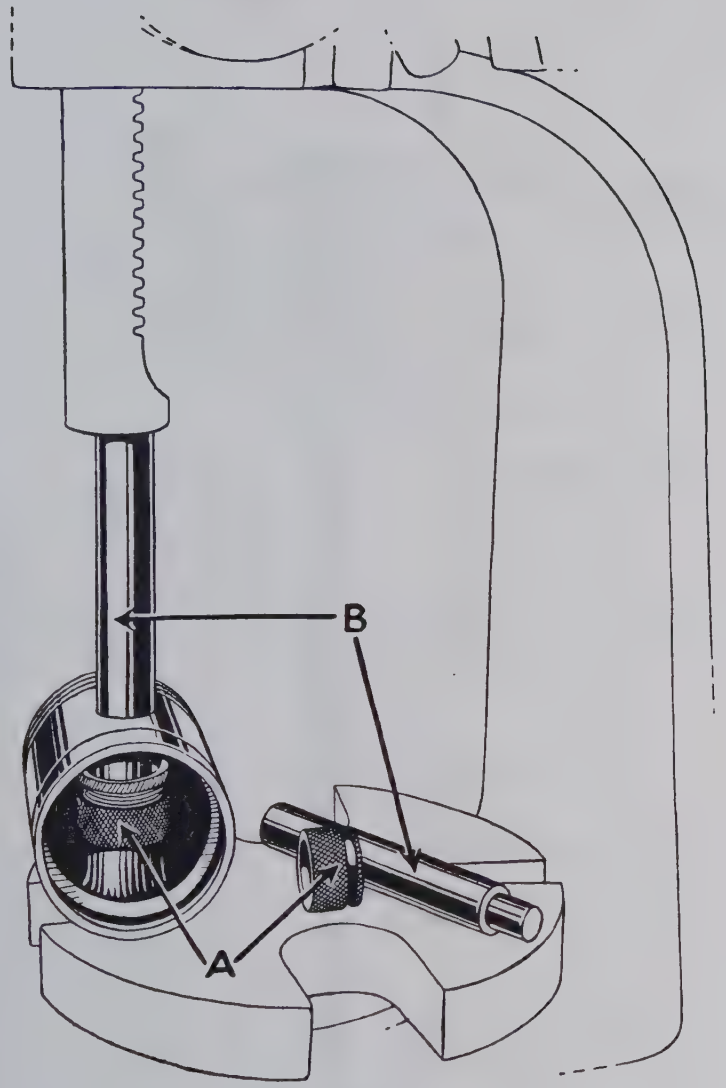
Dimensions for Machining a New Flywheel Housing



Illus. No. 26
Lifting Engine From Chassis

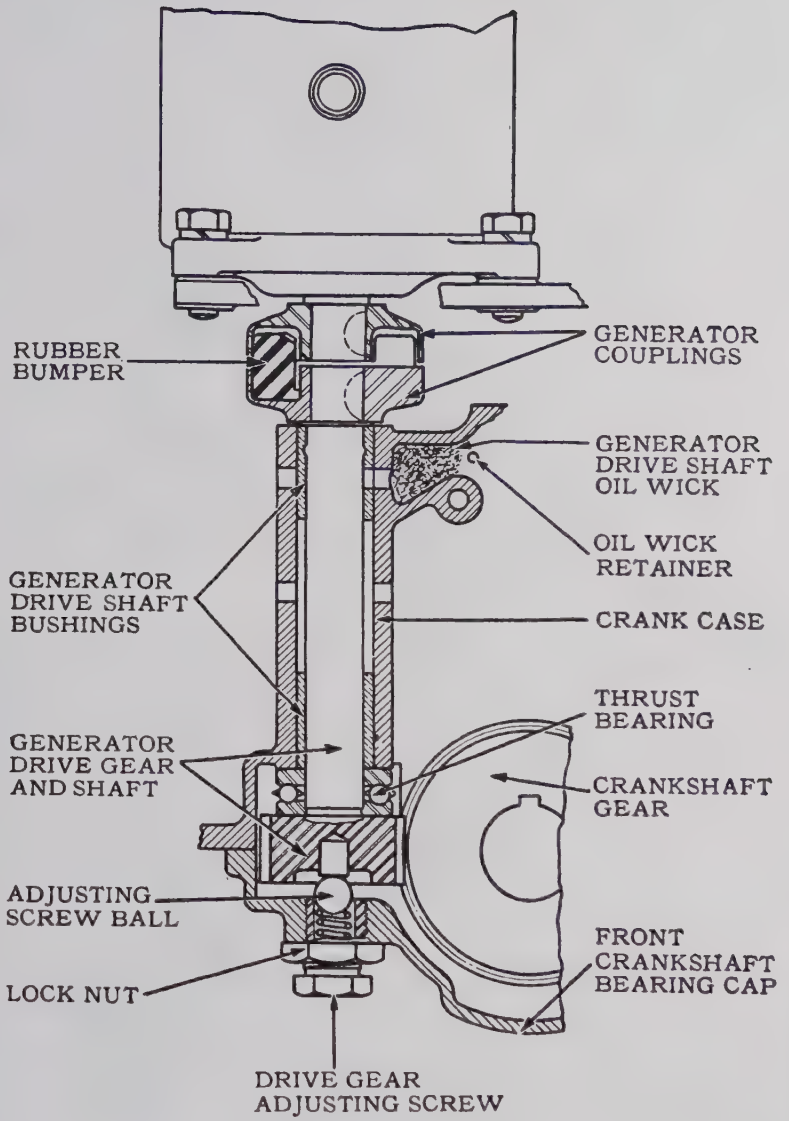


Illus. No. 27
Lifting Off Cylinder Head



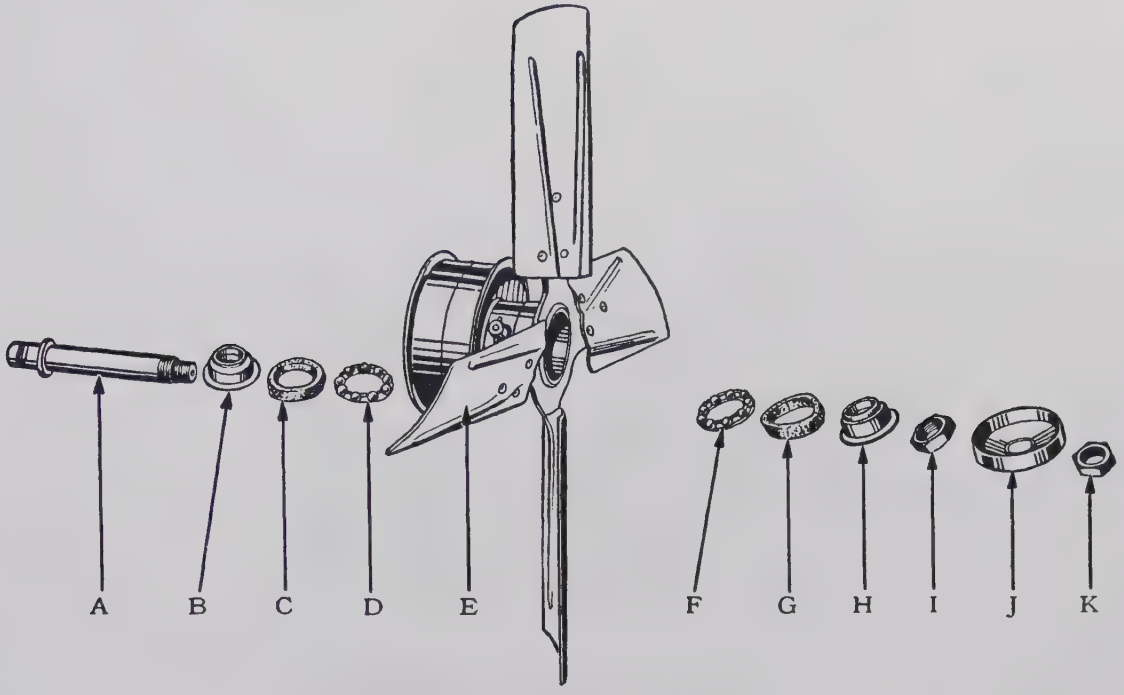
Illus. No. 28

Pressing Out Piston Bushings

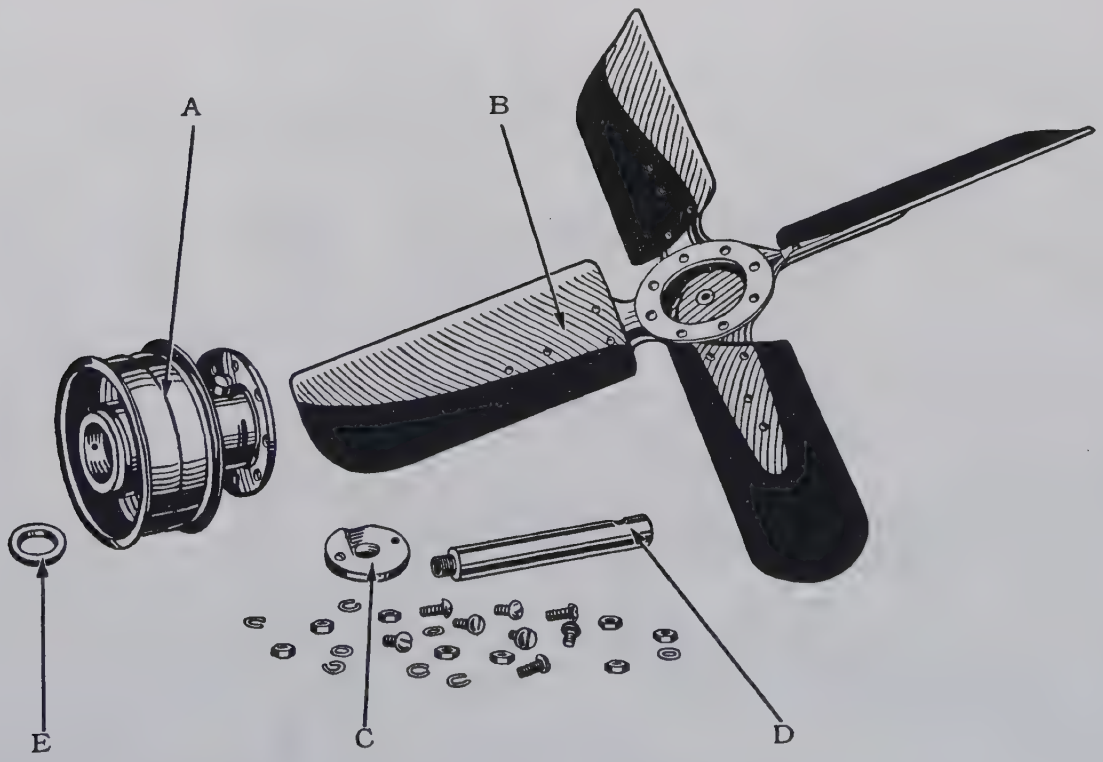


Illus. No. 29

Sectional View Through Generator Drive



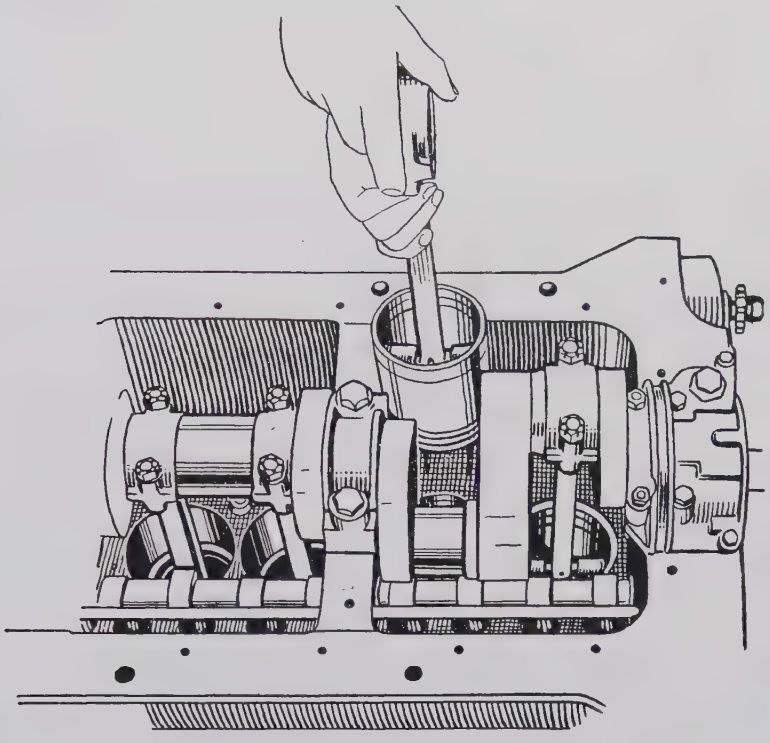
Illus. No. 30
Ball Bearing Fan Disassembled



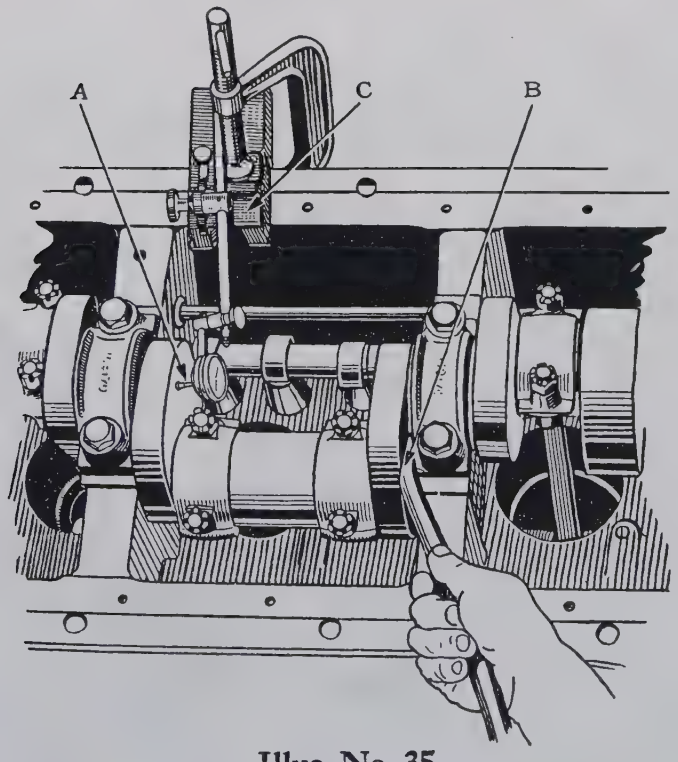
Illus. No. 31
Plain Bearing Fan Disassembled

Illus. No. 32
Method of Lifting Front of Car

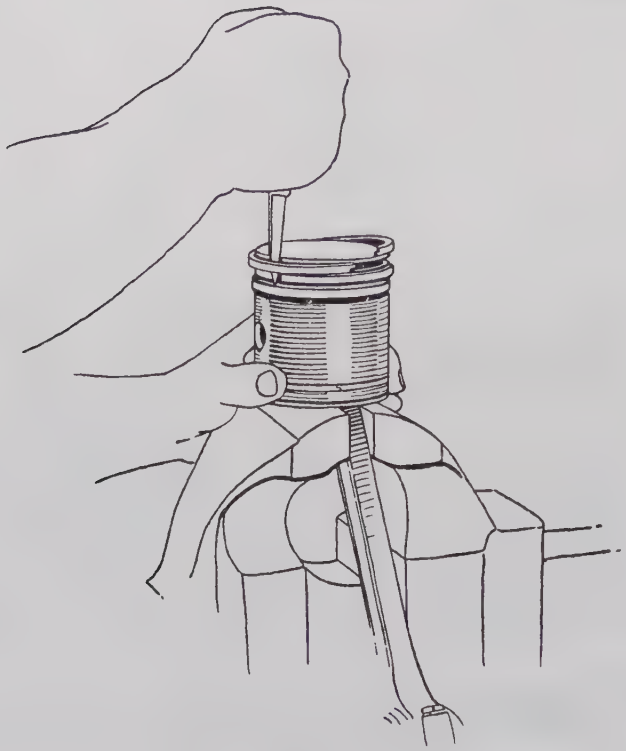
Illus. No. 33
Front of Car Supported by Horses



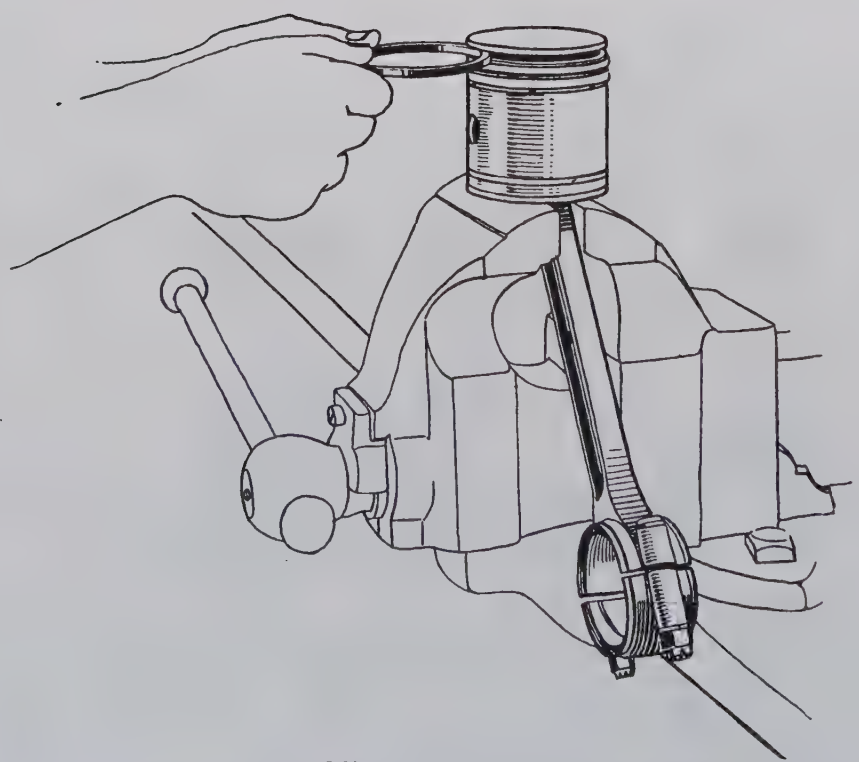
Illus. No. 34
Removing Piston and Connecting Rod



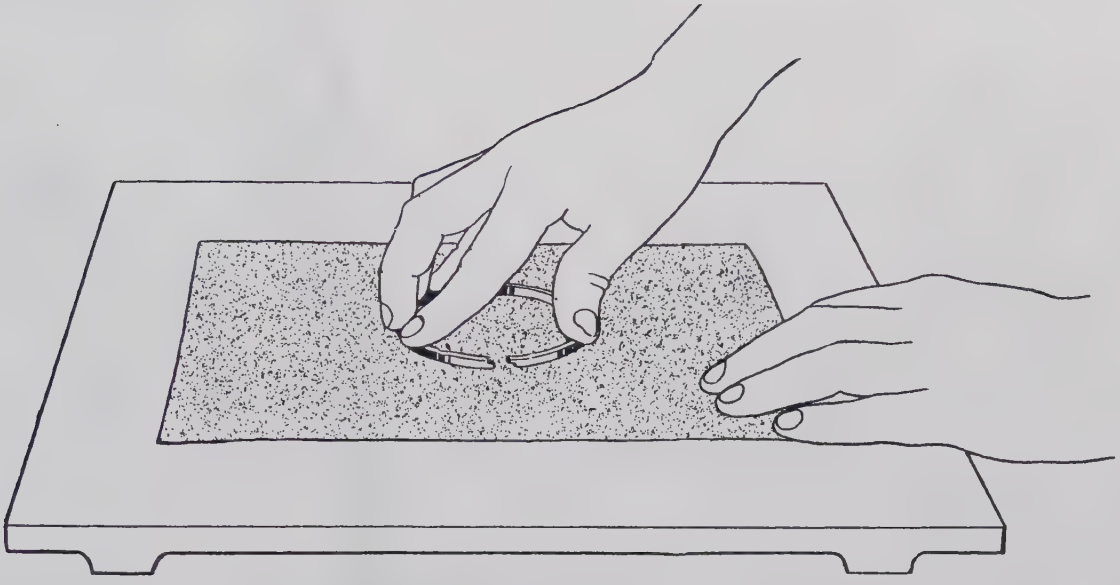
Illus. No. 35
Testing Crankshaft End Play with Surface Indicator Gauge



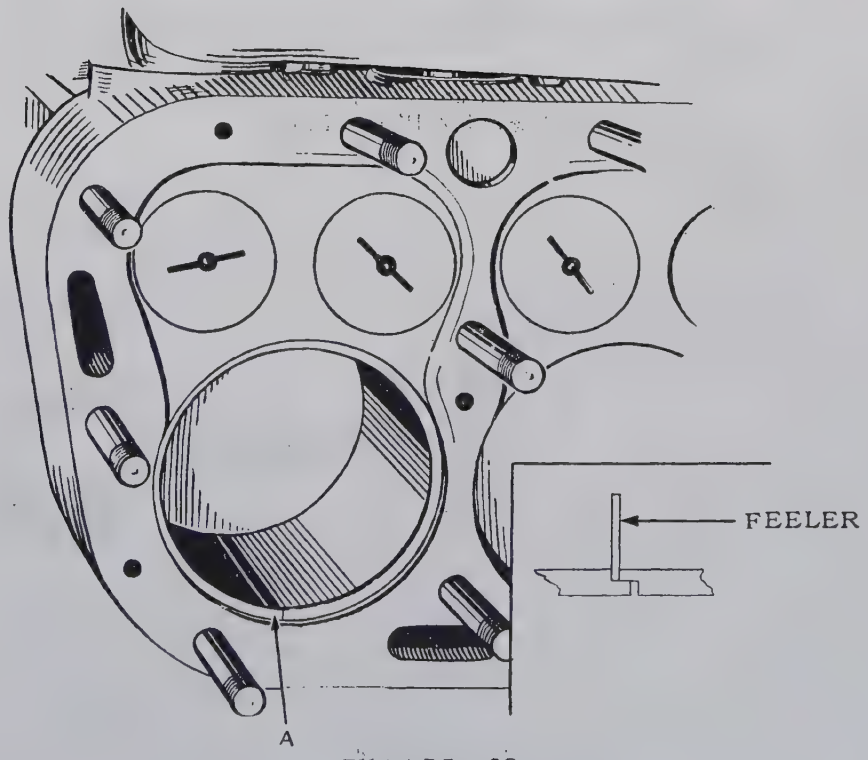
Illus. No. 36
Removing Ring From Piston



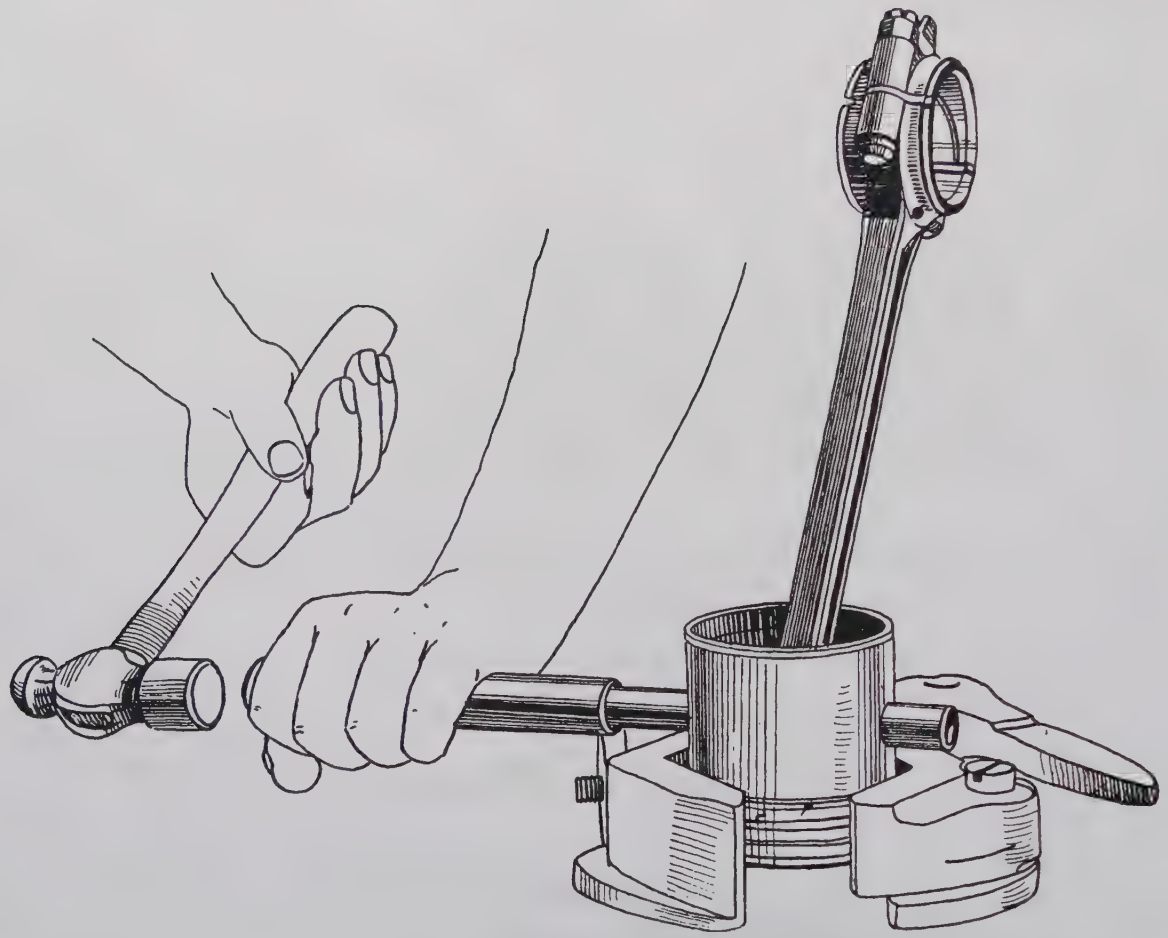
Illus. No. 37
Fitting Ring to Piston Groove



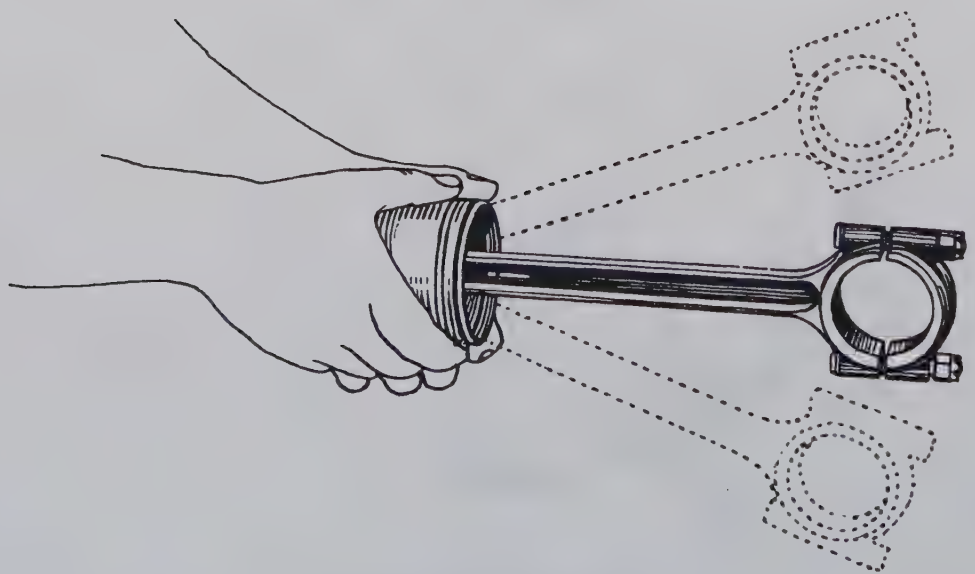
Illus. No. 38
Dressing Piston Ring With Emery Cloth On
A Surface Plate



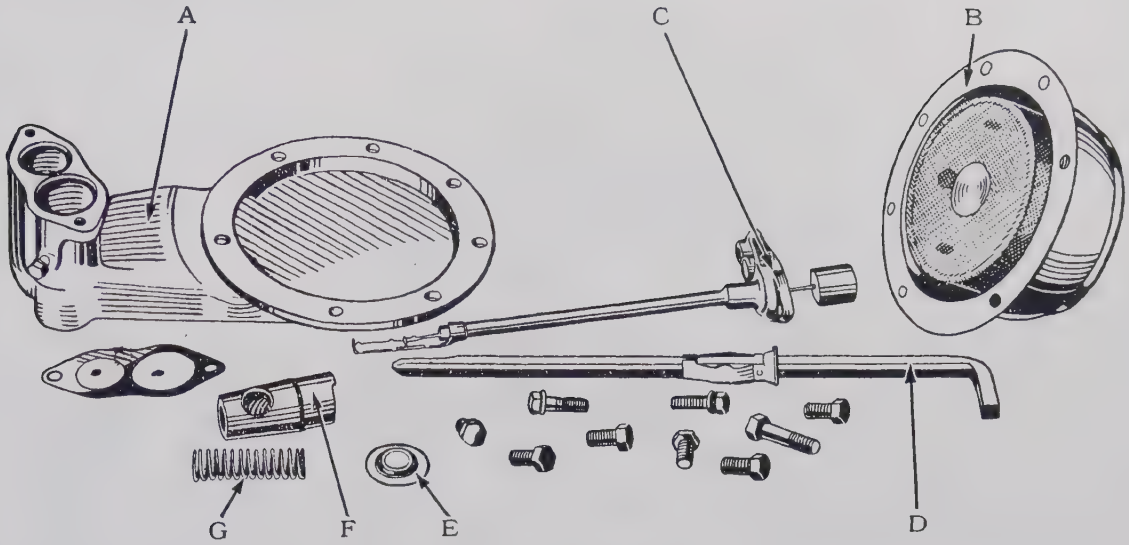
Illus. No. 39
Fitting Piston Ring In Cylinder



Illus. No. 40
Removing Piston Pin

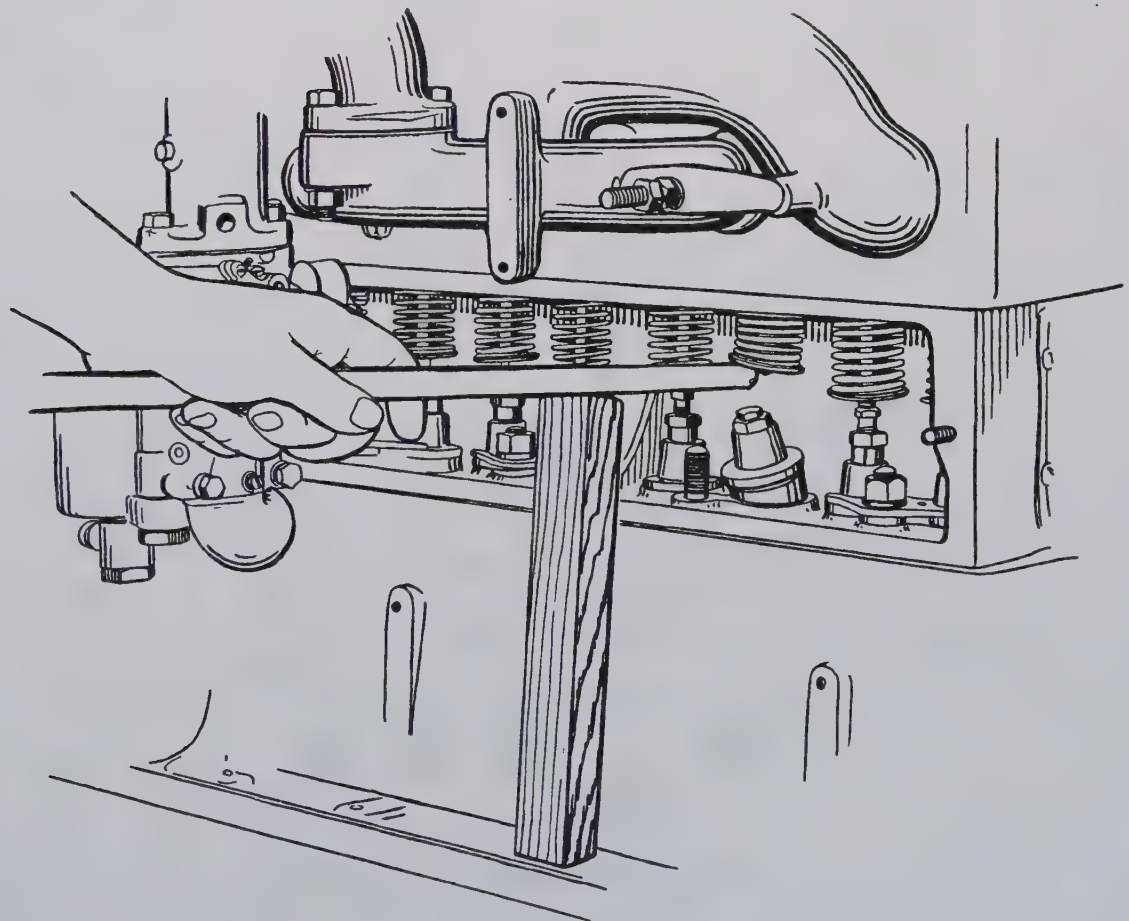


Illus. No. 41
Testing Piston Pin Fit



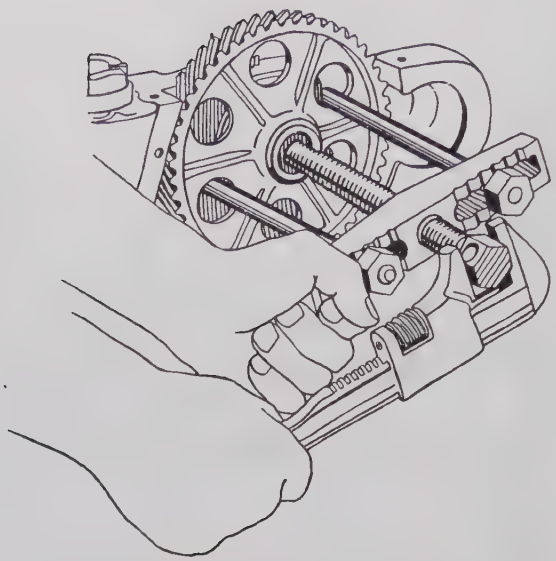
Illus. No. 42

Oil Pan Strainer Base and Drain Valve—Disassembled

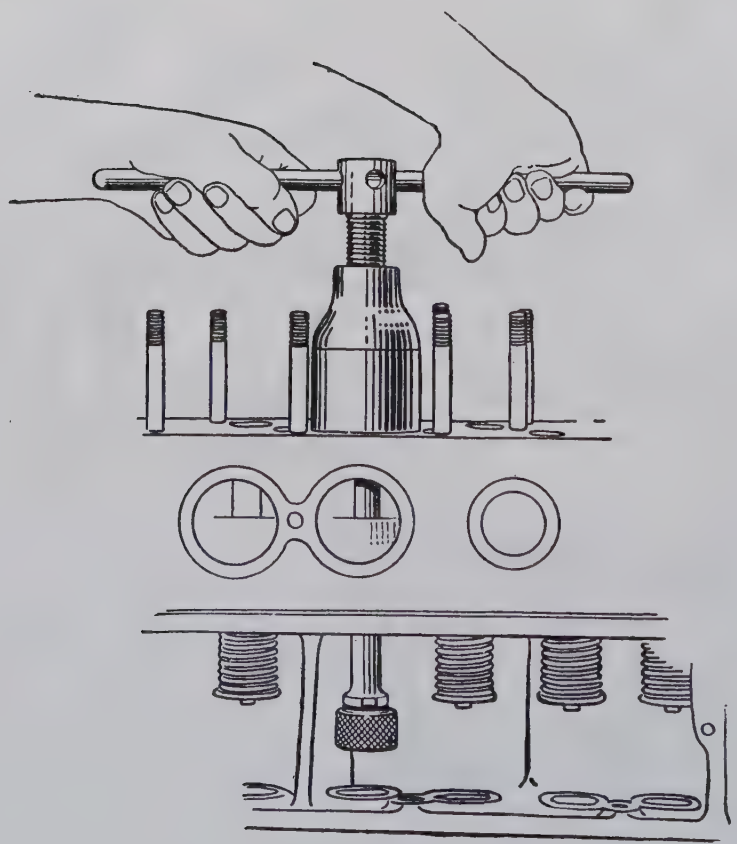


Illus. No. 43

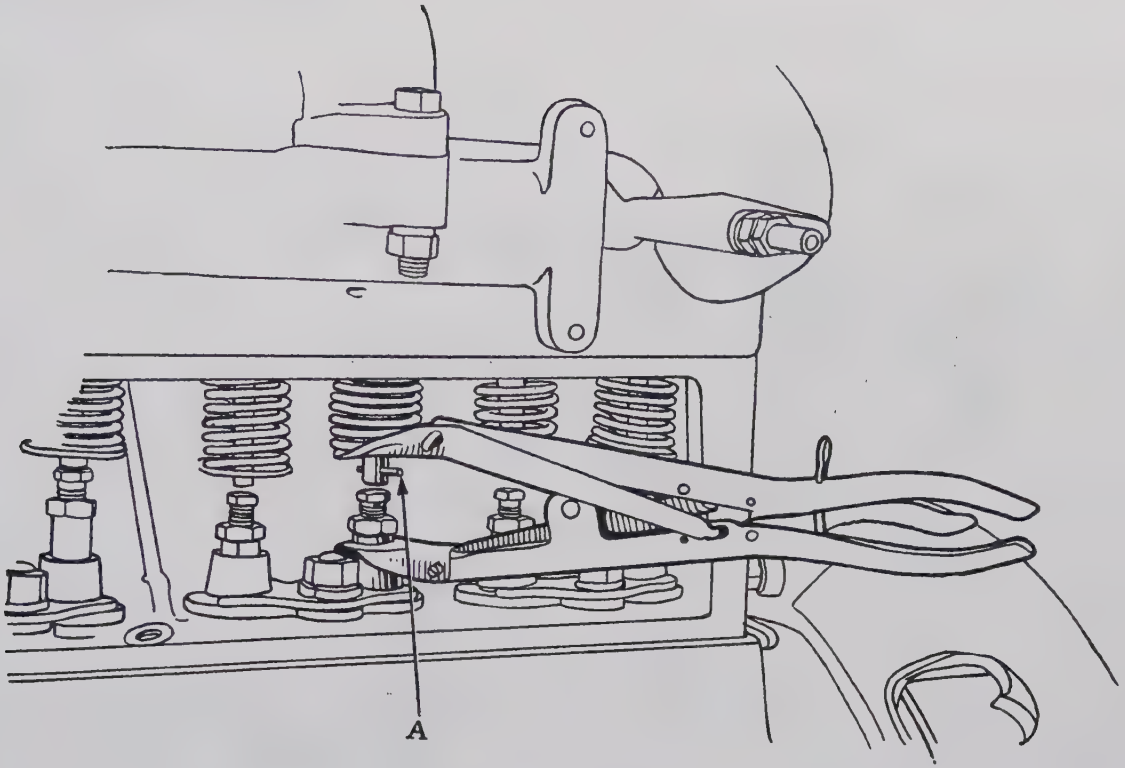
Removing Push Rod and Guide Assembly



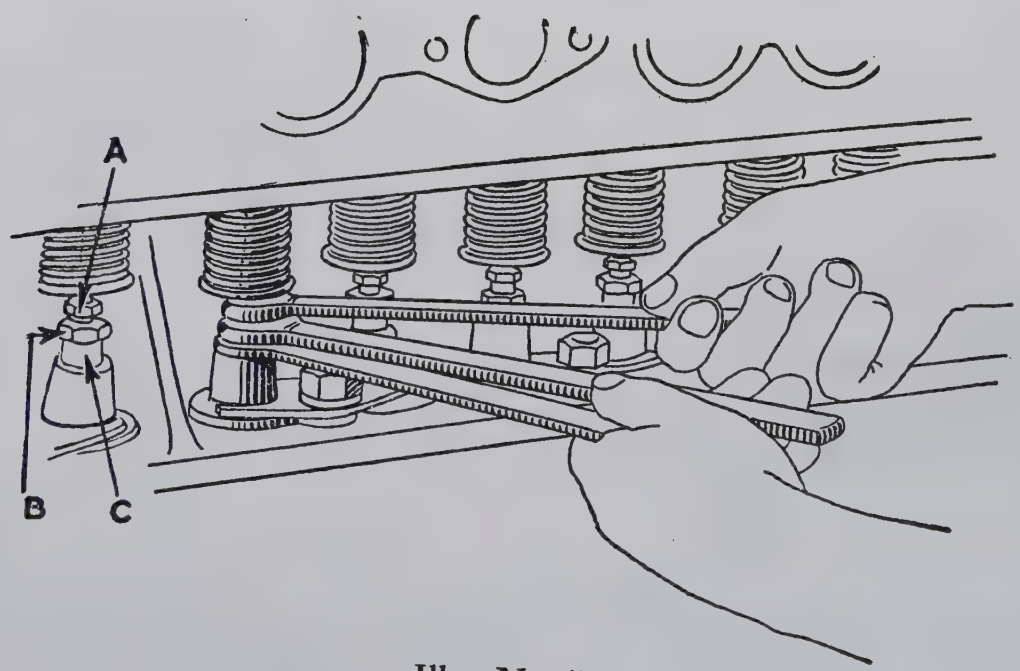
Illus. No. 44
Pulling Camshaft Gear



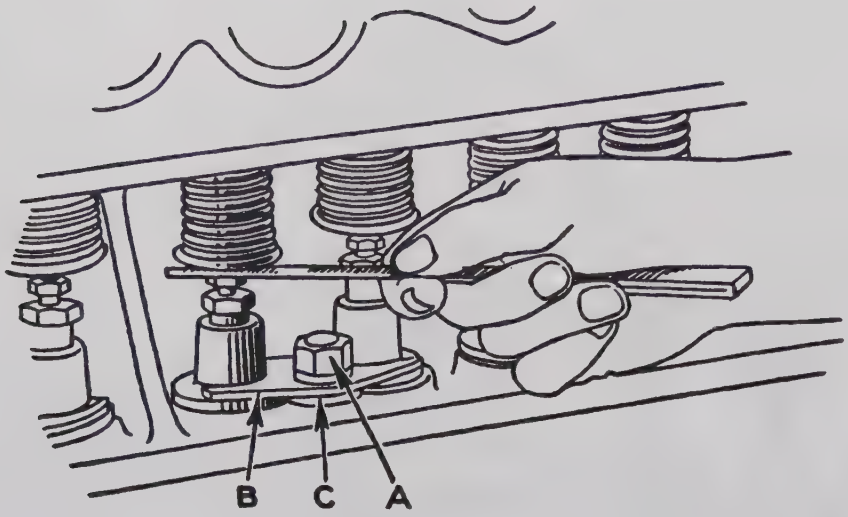
Illus. No. 45
Installing Valve Guide



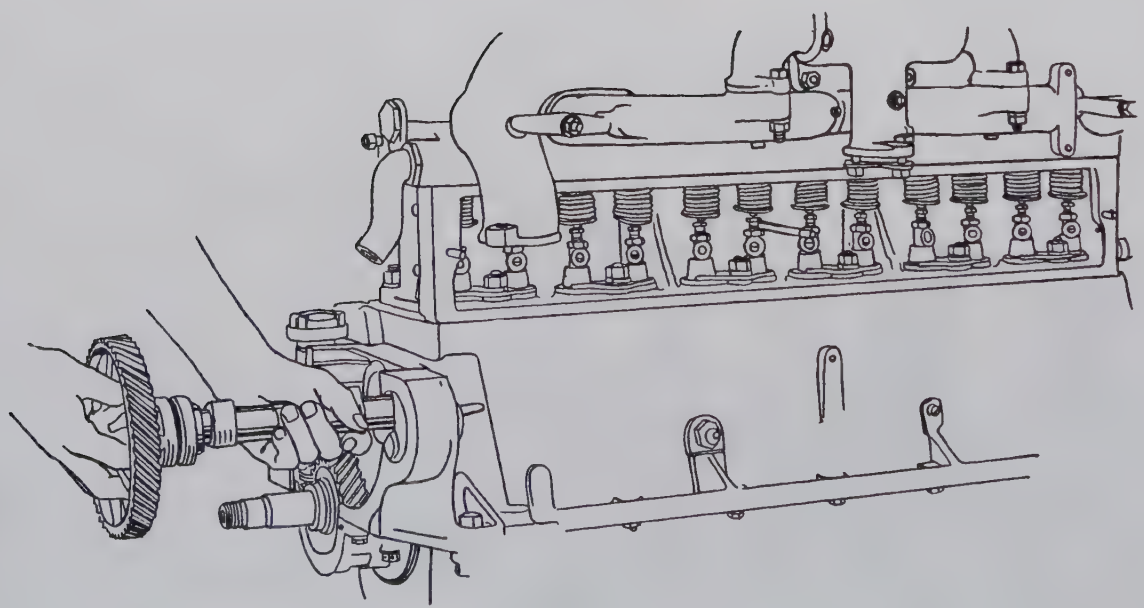
Illus. No. 46
Removing Valve



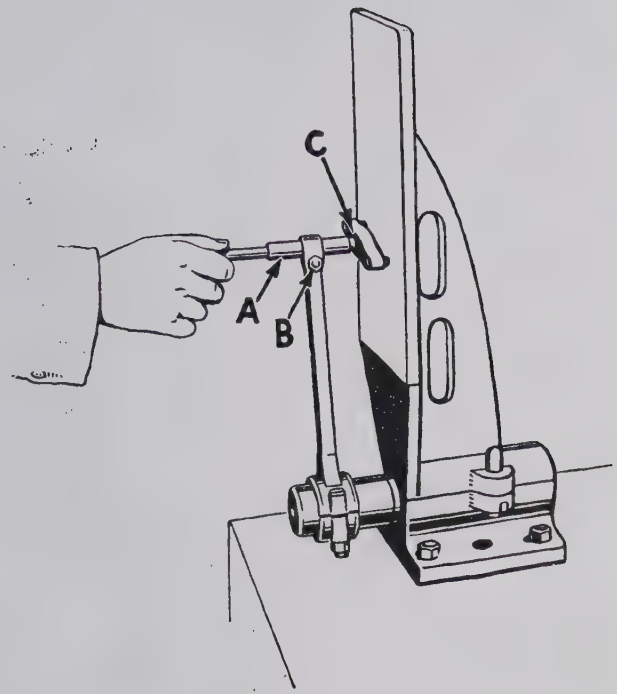
Illus. No. 47
Adjusting Tappets



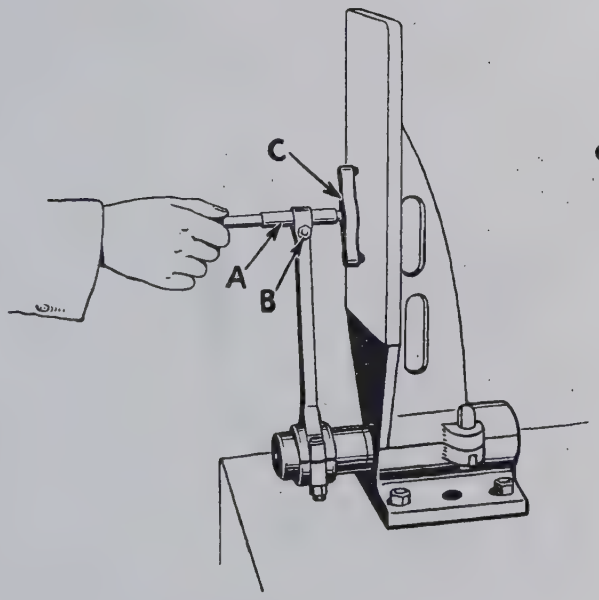
Illus. No. 48
Gauging Valve-Tappet Clearance



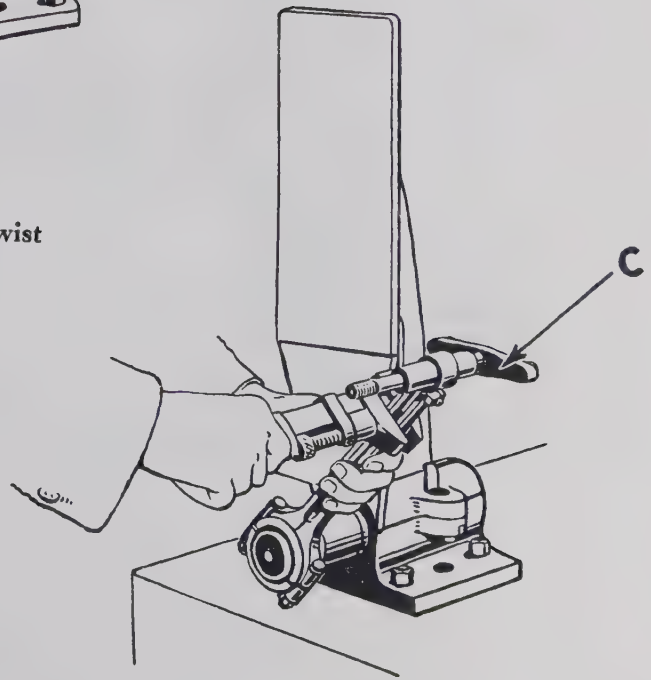
Illus. No. 49
Removing Camshaft—Showing Push Rods Blocked Up With Washers



Illus. No. 50
Checking Connecting Rod For Twist



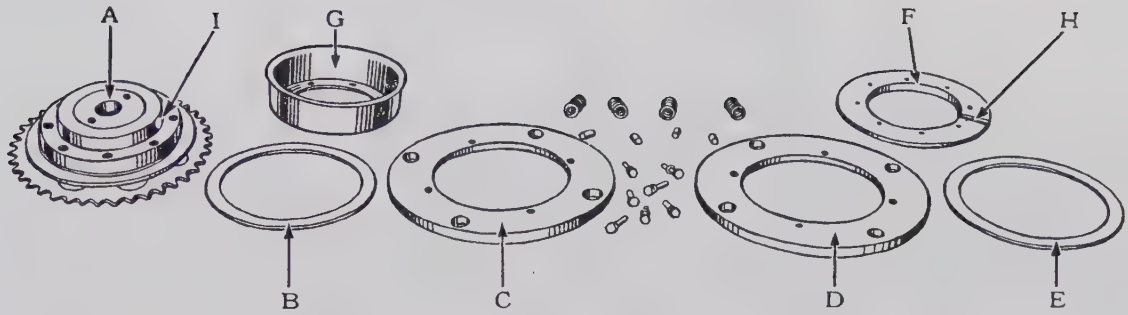
Illus. No. 51
Checking Connecting Rod For Bend



Illus. No. 52
Straightening Connecting Rod

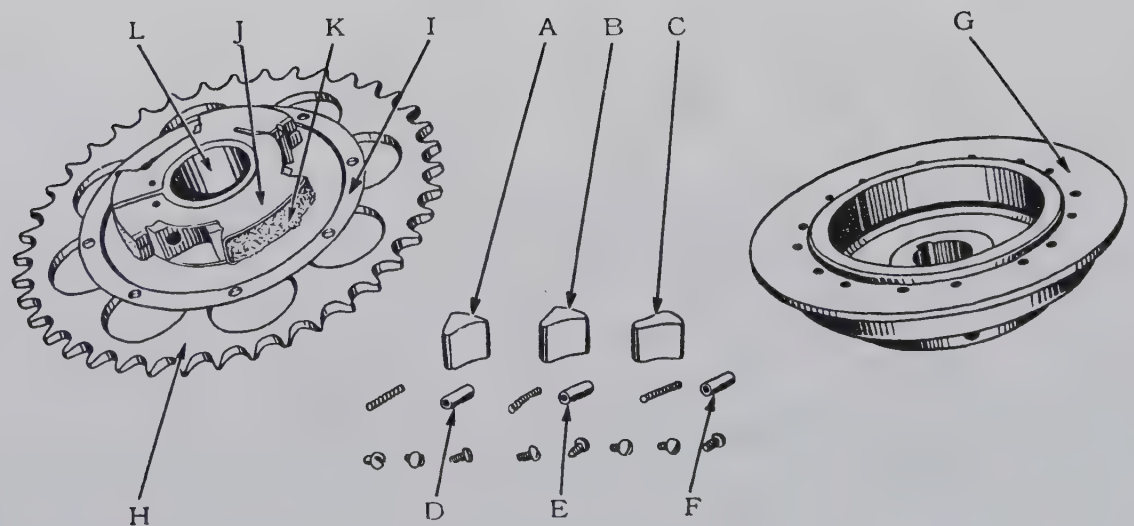
Illus. No. 53
Sectional View Through Starter Clutch and Vibration Damper

Illus. No. 54
Pulling Starter Clutch



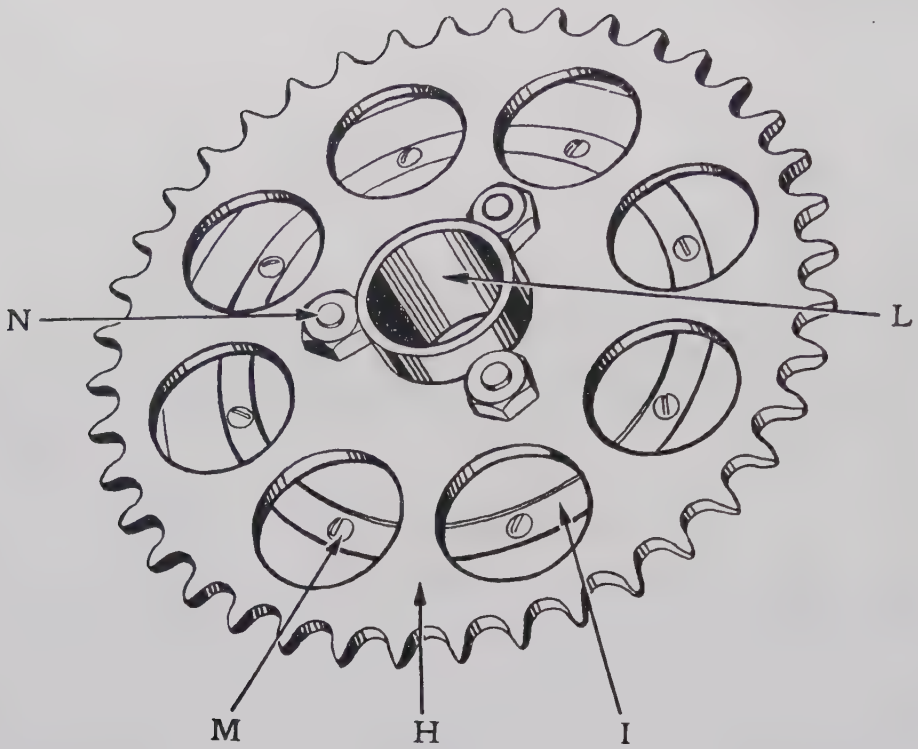
Illus. No. 55

Vibration Damper—Disassembled

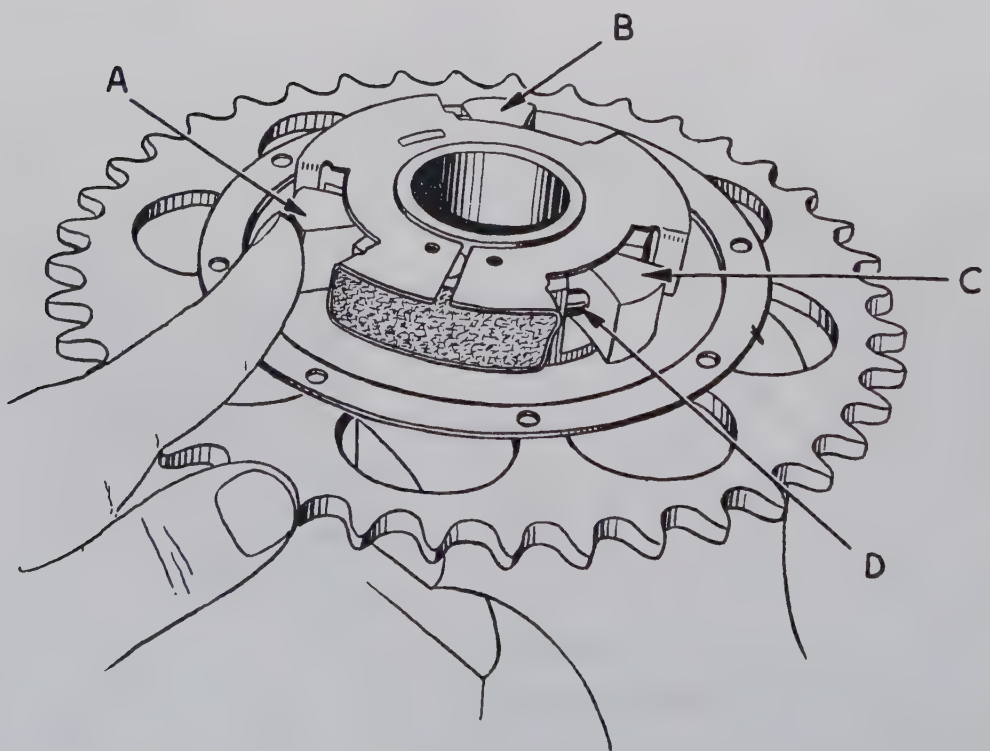


Illus. No. 56

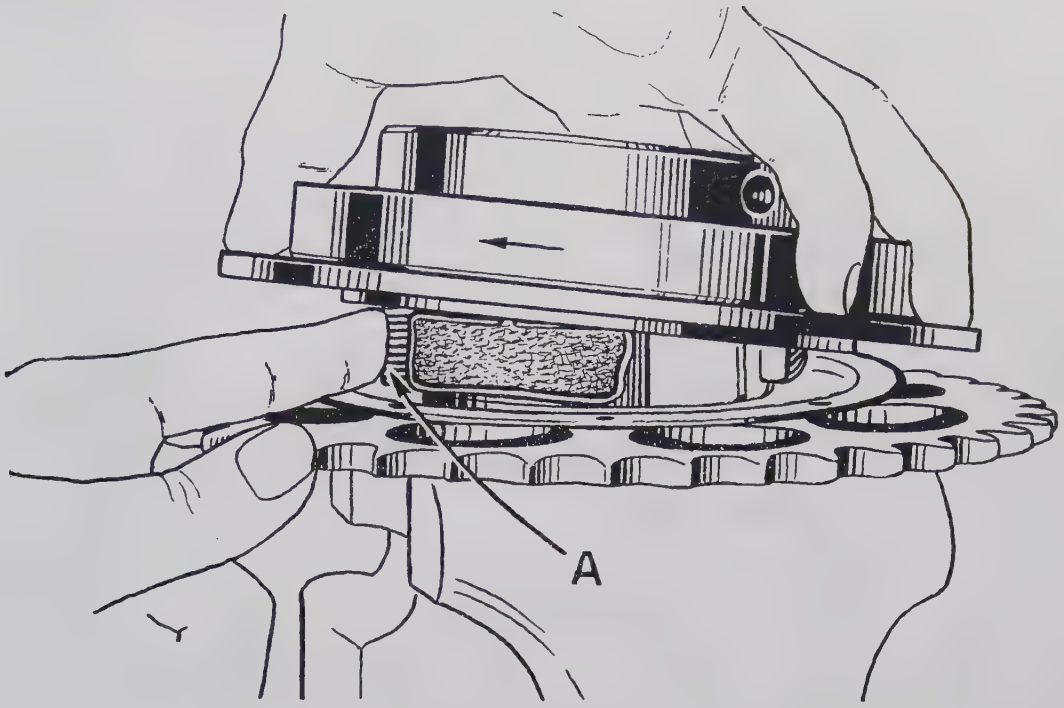
Starter Clutch—Disassembled



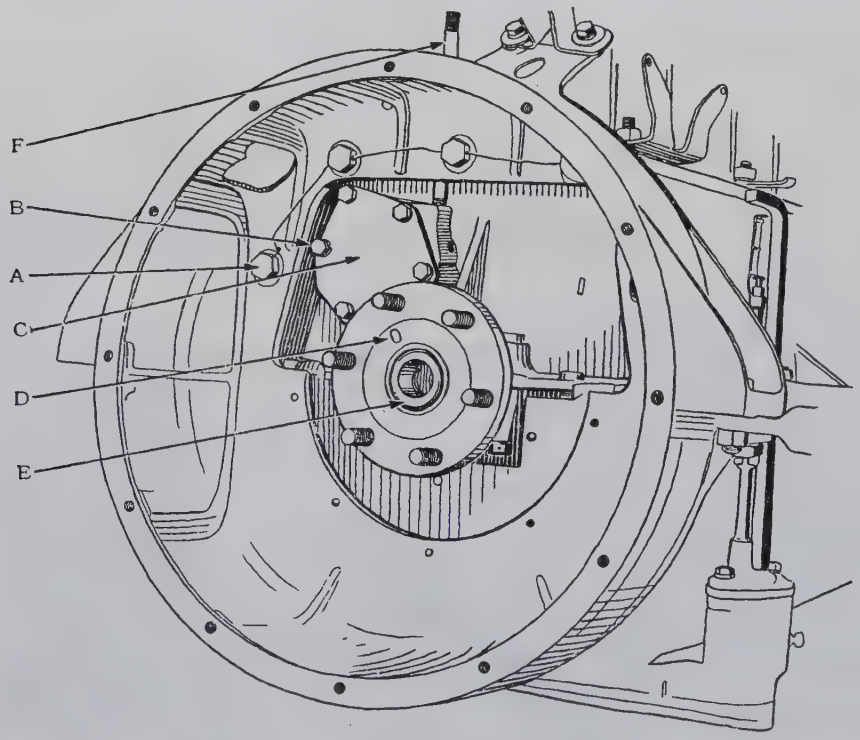
Illus. No. 57
Starter Clutch Sprocket



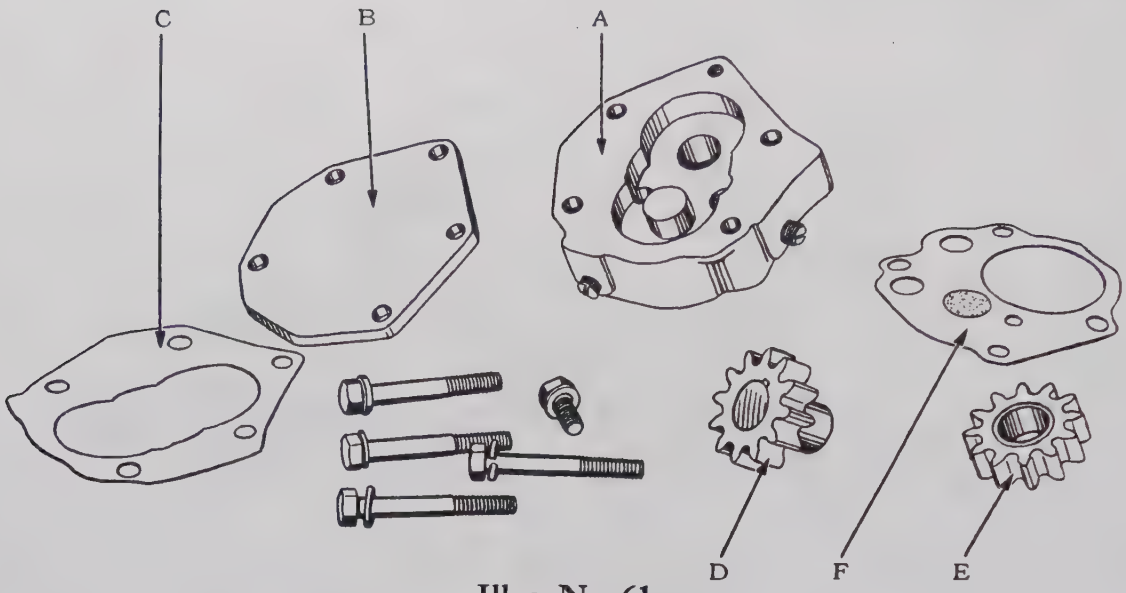
Illus. No. 58
Method of Holding Pawl When Assembling Starter Clutch



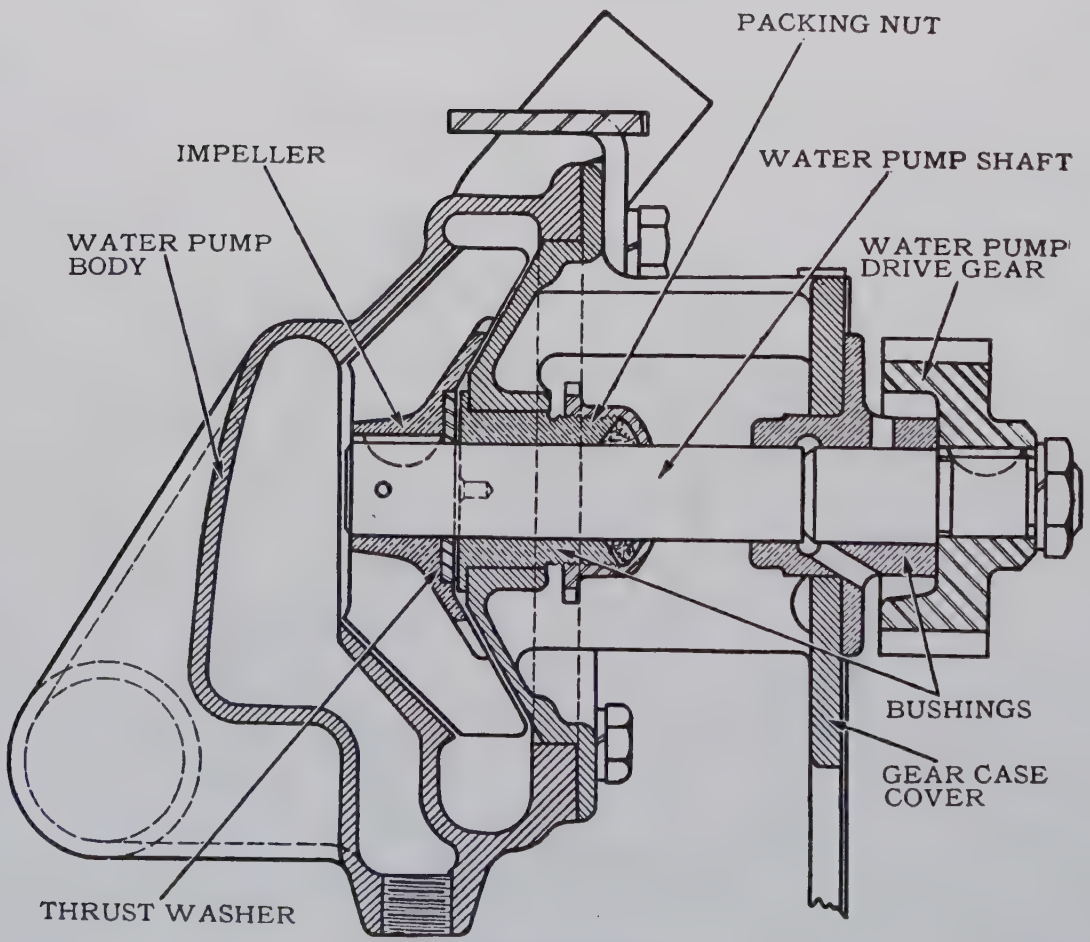
Illus. No. 59
Placing Starter Clutch Housing Over Pawls



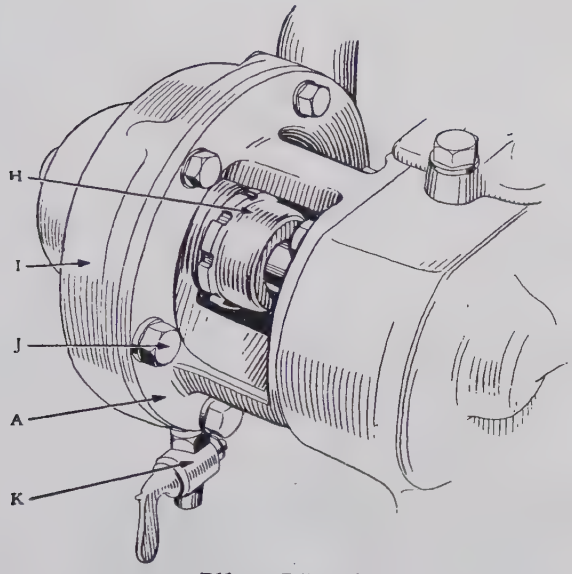
Illus. No. 60
Oil Pump Assembled to Engine



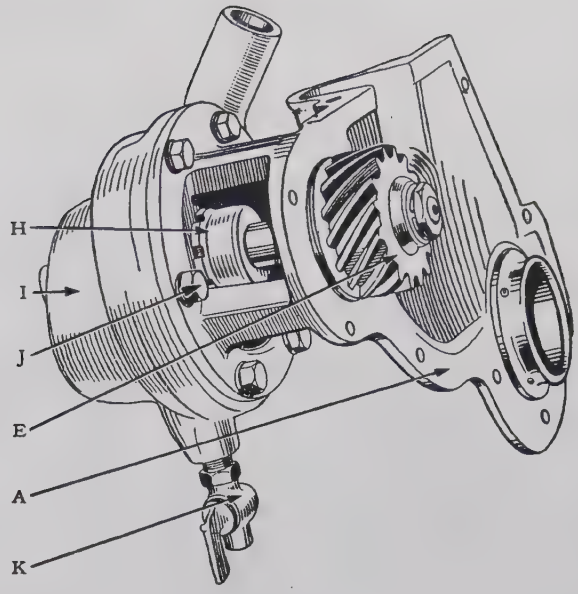
Illus. No. 61
Oil Pump—Disassembled



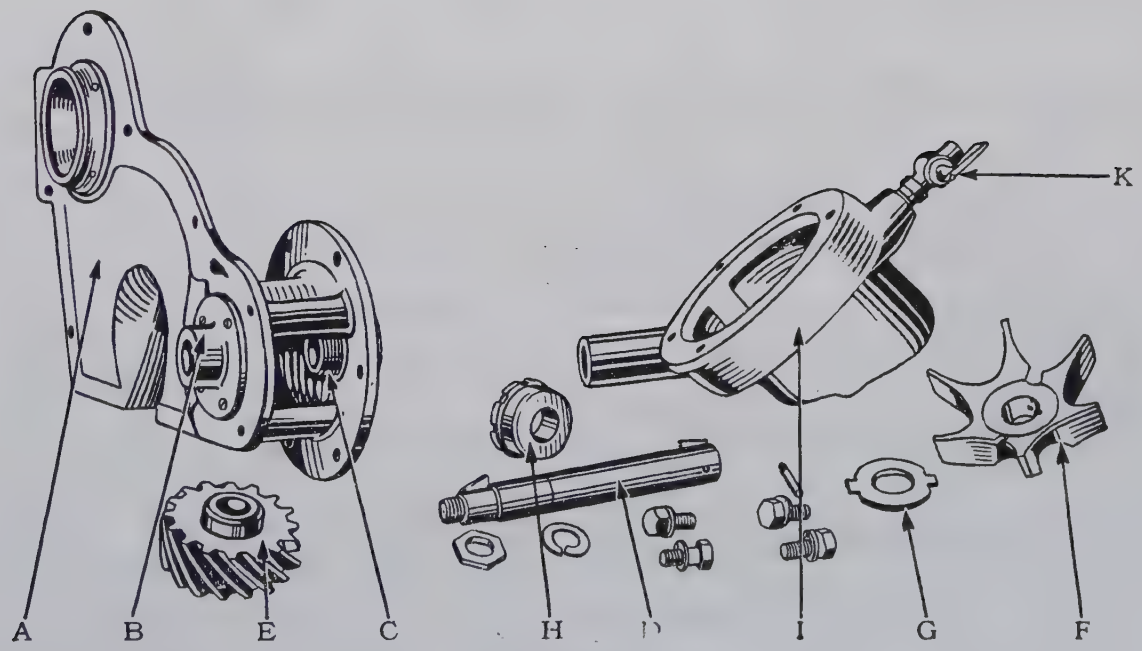
Illus. No. 62
Sectional View Through Water Pump



Illus. No. 63
Water Pump Packing Nut



Illus. No. 64
Water Pump Assembly Removed From Engine



Illus. No. 65
Water Pump—Disassembled

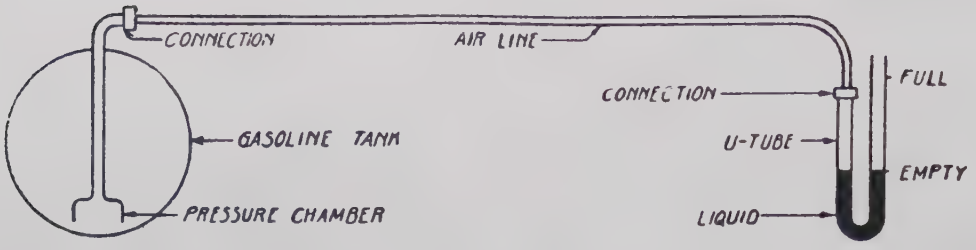


FIG. 1
GAUGE CONNECTED UP WITH TANK EMPTY

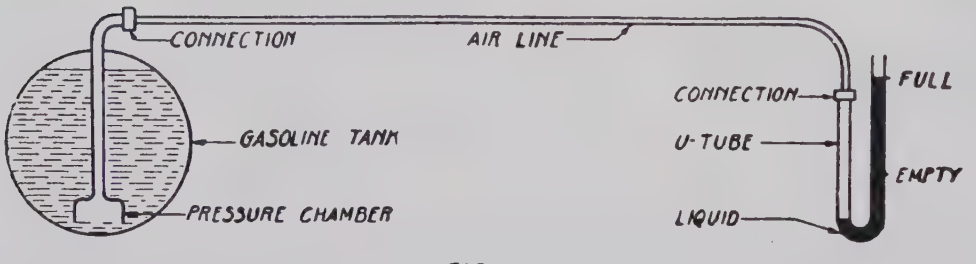


FIG. 2
GAUGE IN OPERATING CONDITION WITH TANK FULL

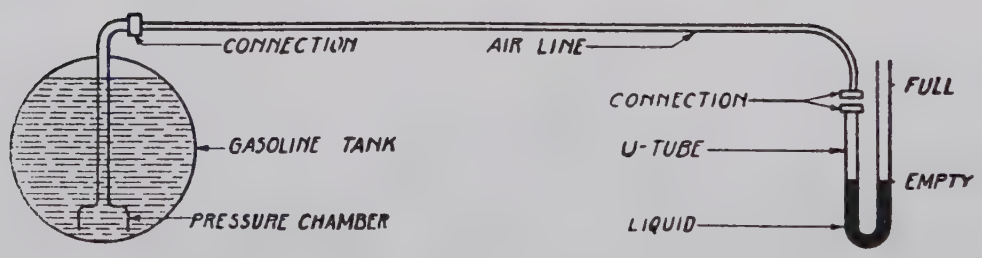


FIG. 3
GAUGE DISCONNECTED WITH FULL TANK WHEN RECONNECTED, CONDITION WILL BE THE SAME BUT AFTER DRIVING THREE MILES CONDITION WILL BE AS IN FIG 2

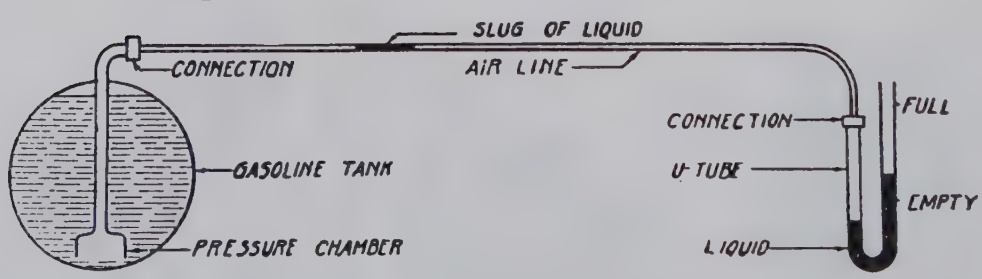
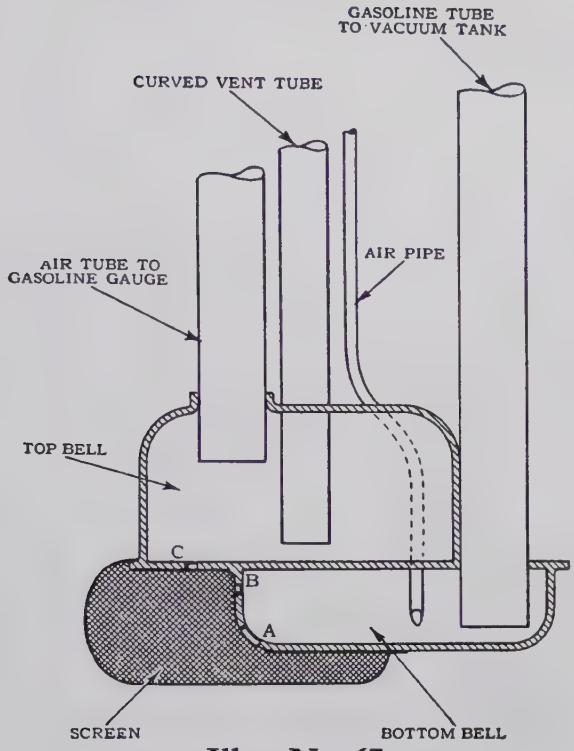
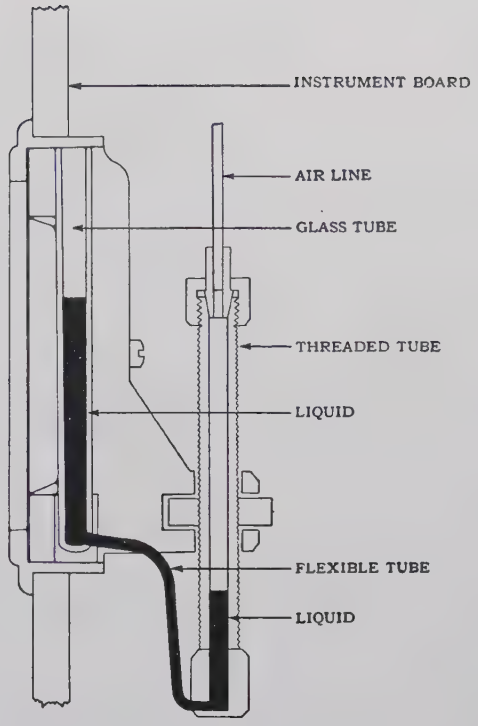


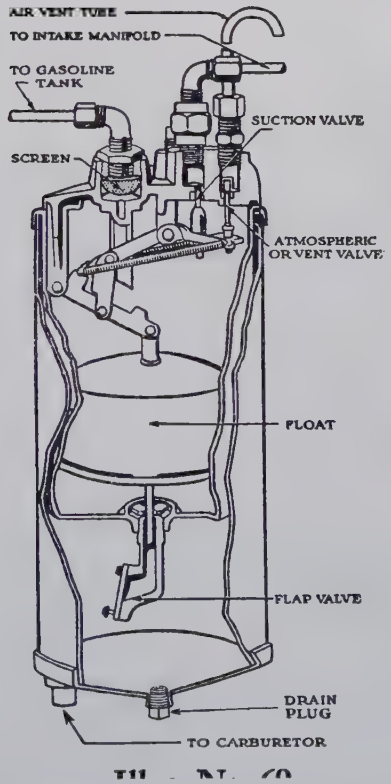
FIG. 4
GAUGE IN OPERATING CONDITION WITH TANK FULL BUT SLUG OF LIQUID IN AIR LINE NOTE INCORRECT READING OF U-TUBE



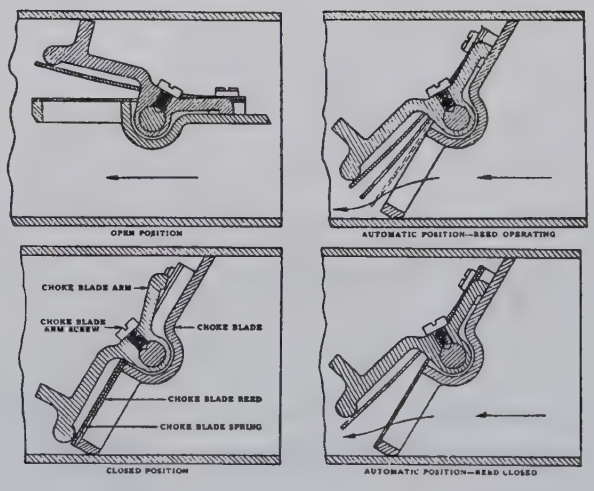
Illus. No. 67
Gasoline Gauge Tank Unit



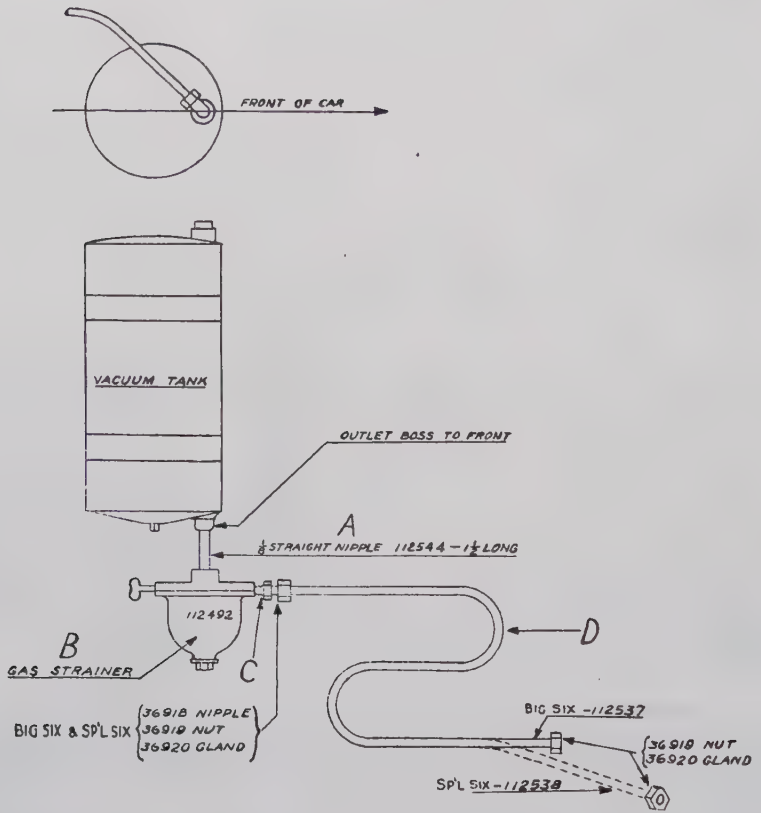
Illus. No. 68
Gasoline Gauge Dash Unit



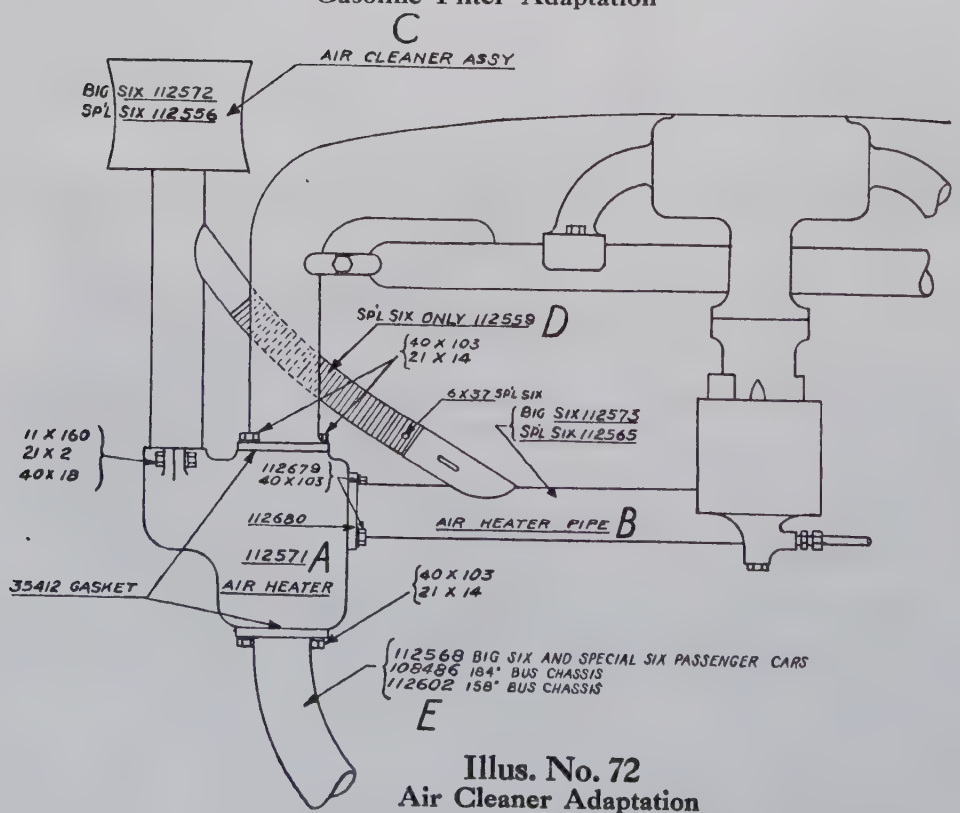
Illus. No. 69



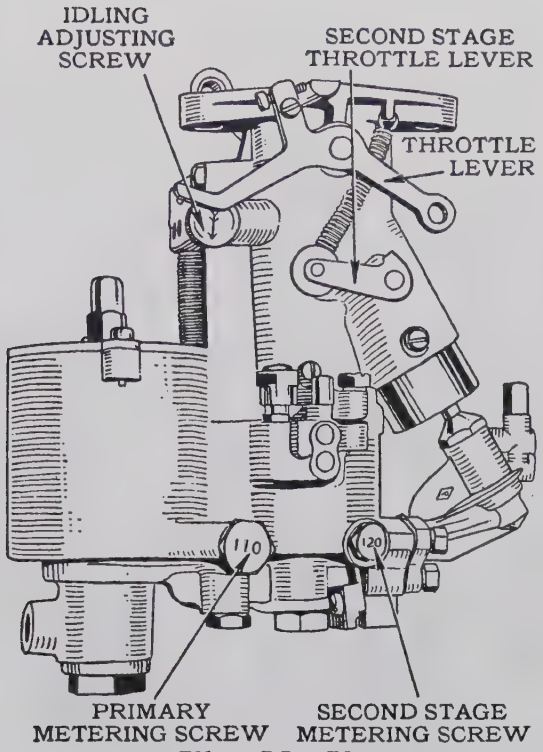
Illus. No. 70
Automatic Choke Valve



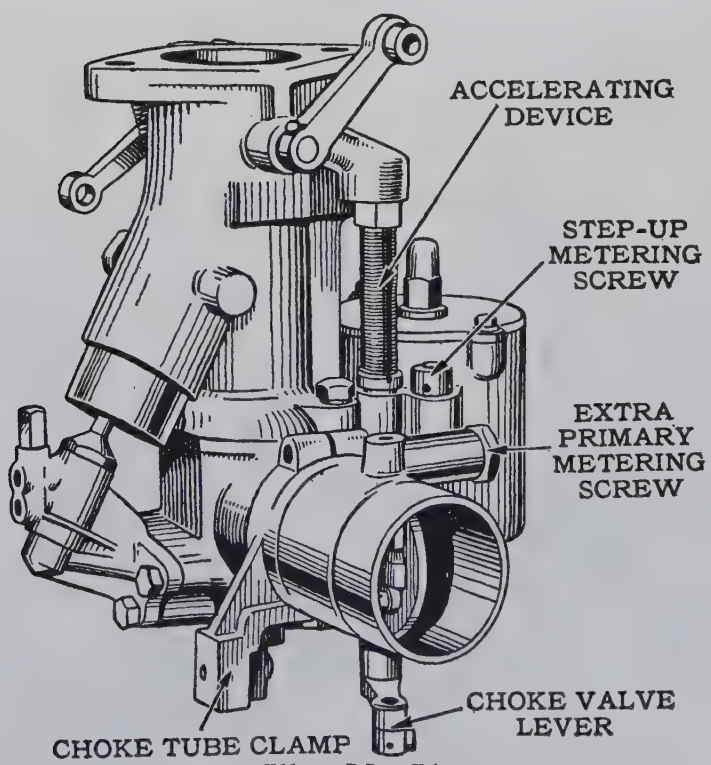
Illus. No. 71
Gasoline Filter Adaptation



Illus. No. 72
Air Cleaner Adaptation



Illus. No. 73
Ball and Ball Carburetor, Model SV-33, Which Started on Big Six Models With Serial No. 2082183



Illus. No. 74
Ball and Ball Carburetor, Model SV-33.

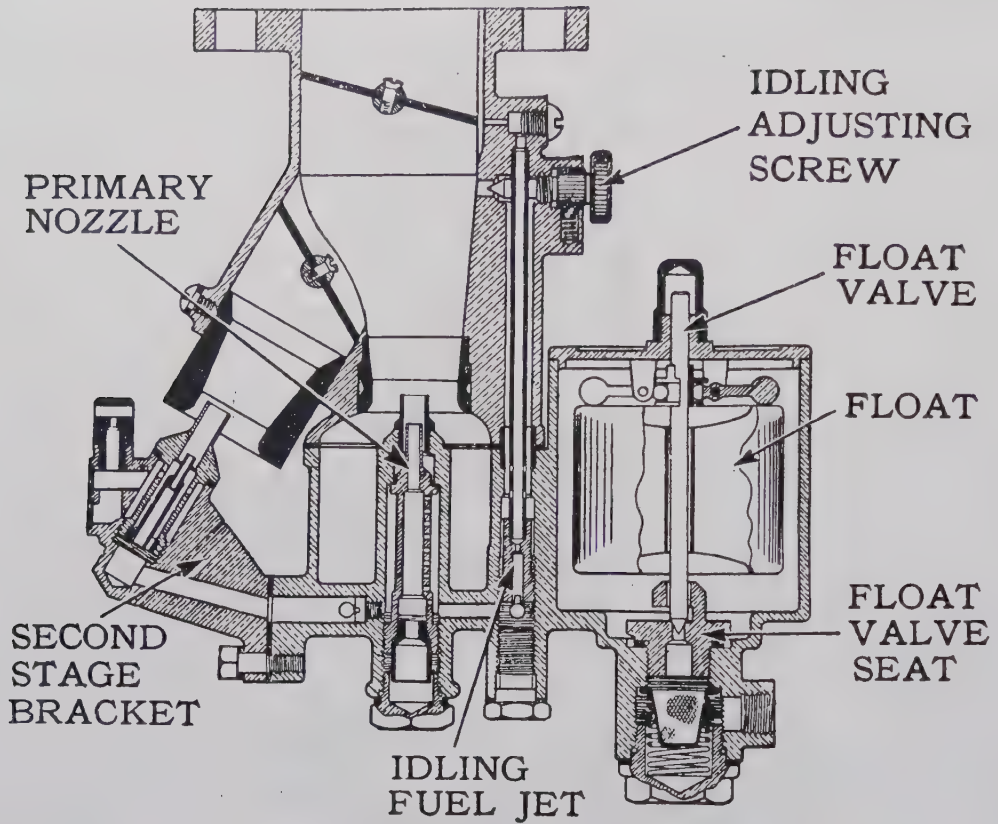


Fig. 1

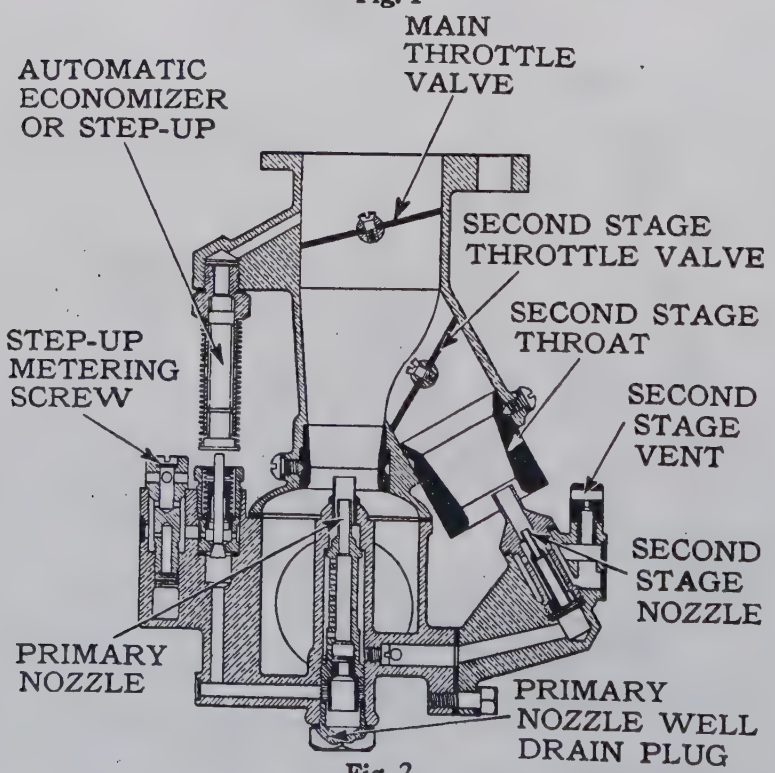


Fig. 2

Illus. No. 75

Sectional Views Through Model SV-33 Ball and Ball Carburetor

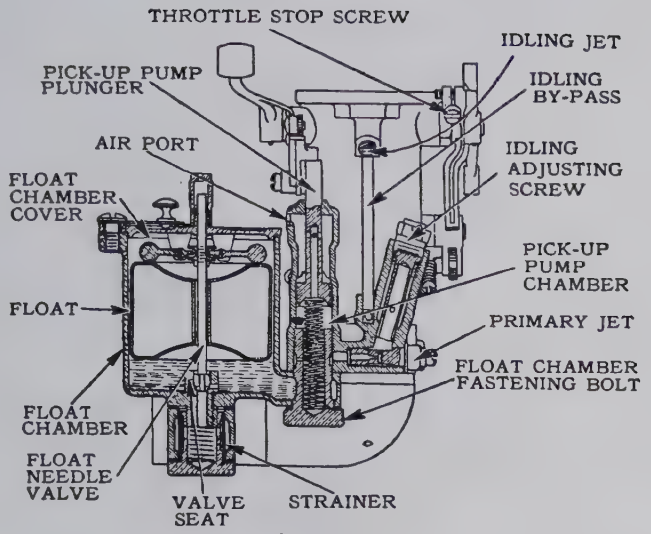


FIG. 1

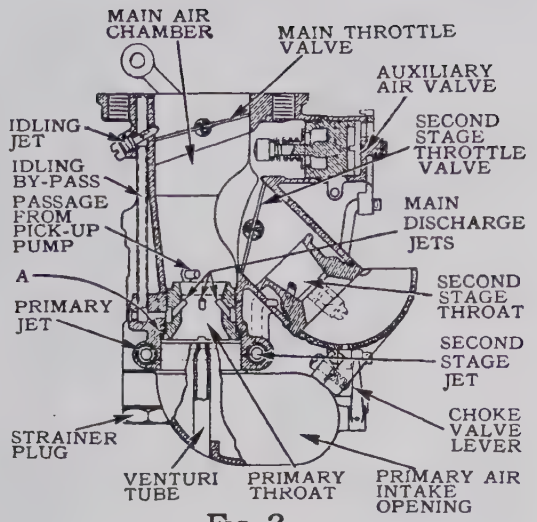


FIG. 2

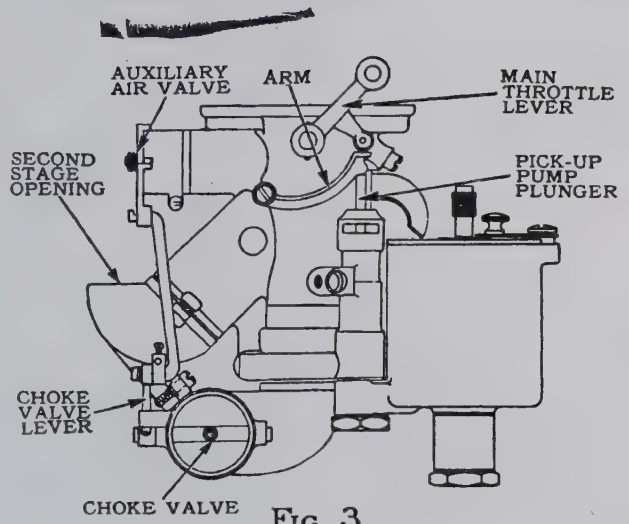


FIG 3

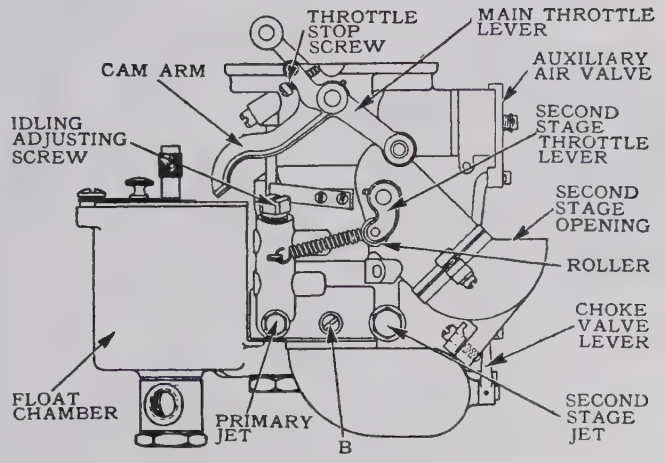


FIG. 4

Illus. No. 76

**Ball and Ball Carburetor—Sectional Views
(Used on Big Six Previous to
Serial No. 2082183)**

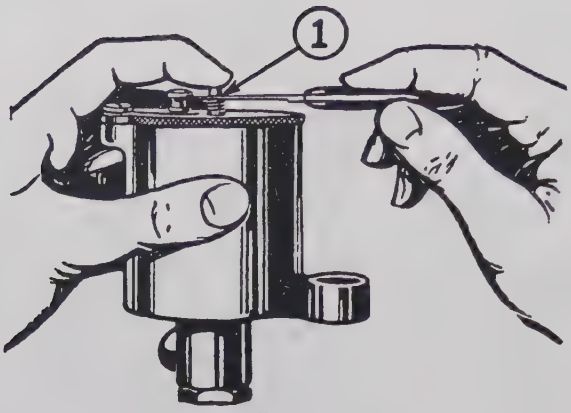


Fig. 1

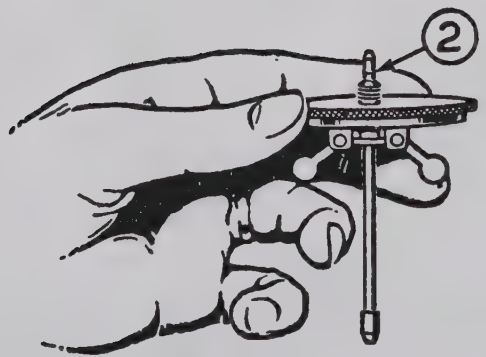


Fig. 2

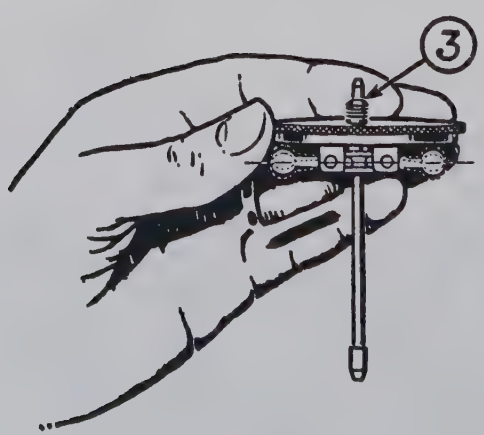


Fig. 3

Illus. No. 77

Checking of Float Level on Ball and Ball Carburetor

FIG. 3

FIG. 2

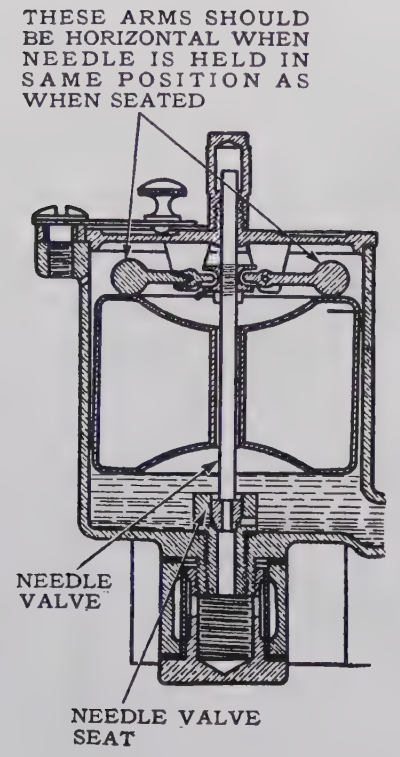
FIG. 1

FIG. 5

FIG. 4

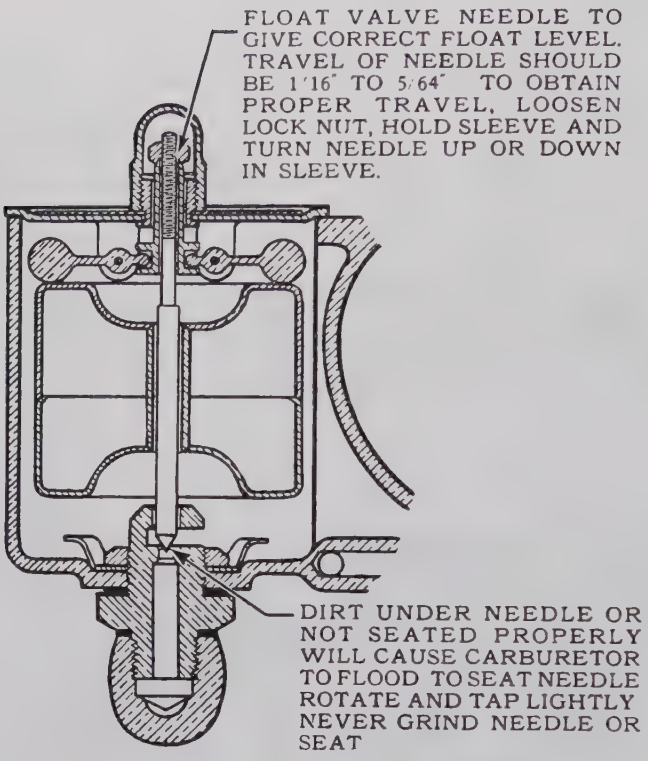
Illus No. 78

Stromberg Carburetor—Sectional Views (Special Six)



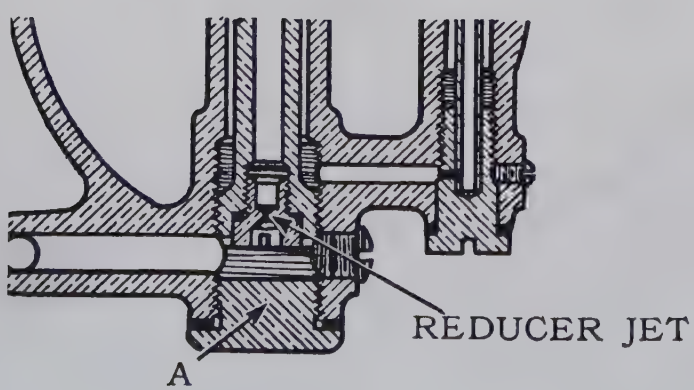
Illus. No. 79

Ball and Ball Carburetor Float Chamber


FLOAT VALVE NEEDLE TO GIVE CORRECT FLOAT LEVEL. TRAVEL OF NEEDLE SHOULD BE 1/16" TO 5/64" TO OBTAIN PROPER TRAVEL, LOOSEN LOCK NUT, HOLD SLEEVE AND TURN NEEDLE UP OR DOWN IN SLEEVE.
DIRT UNDER NEEDLE OR NOT SEATED PROPERLY WILL CAUSE CARBURETOR TO FLOOD TO SEAT NEEDLE ROTATE AND TAP LIGHTLY NEVER GRIND NEEDLE OR SEAT

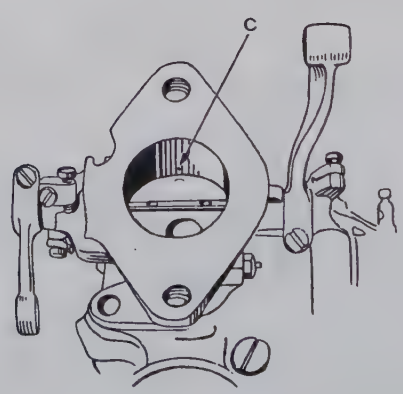
Illus. No. 80

Stromberg Carburetor Float Chamber



Illus. No. 81

asoline Reducer in Stromberg Carburetor

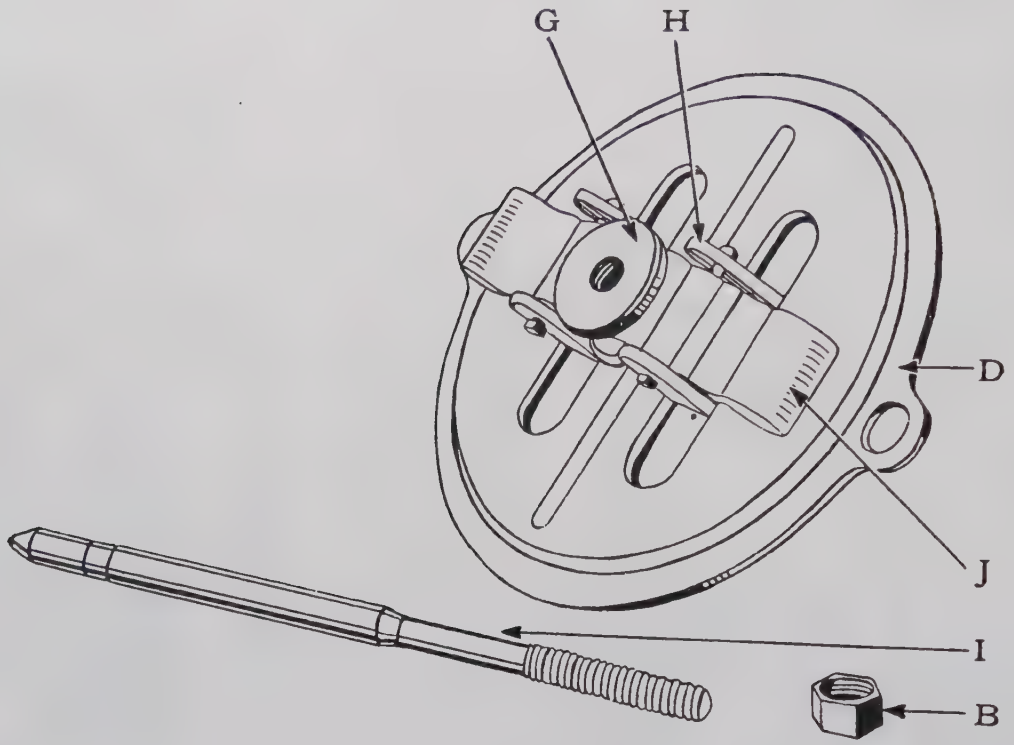


Illus. No. 82

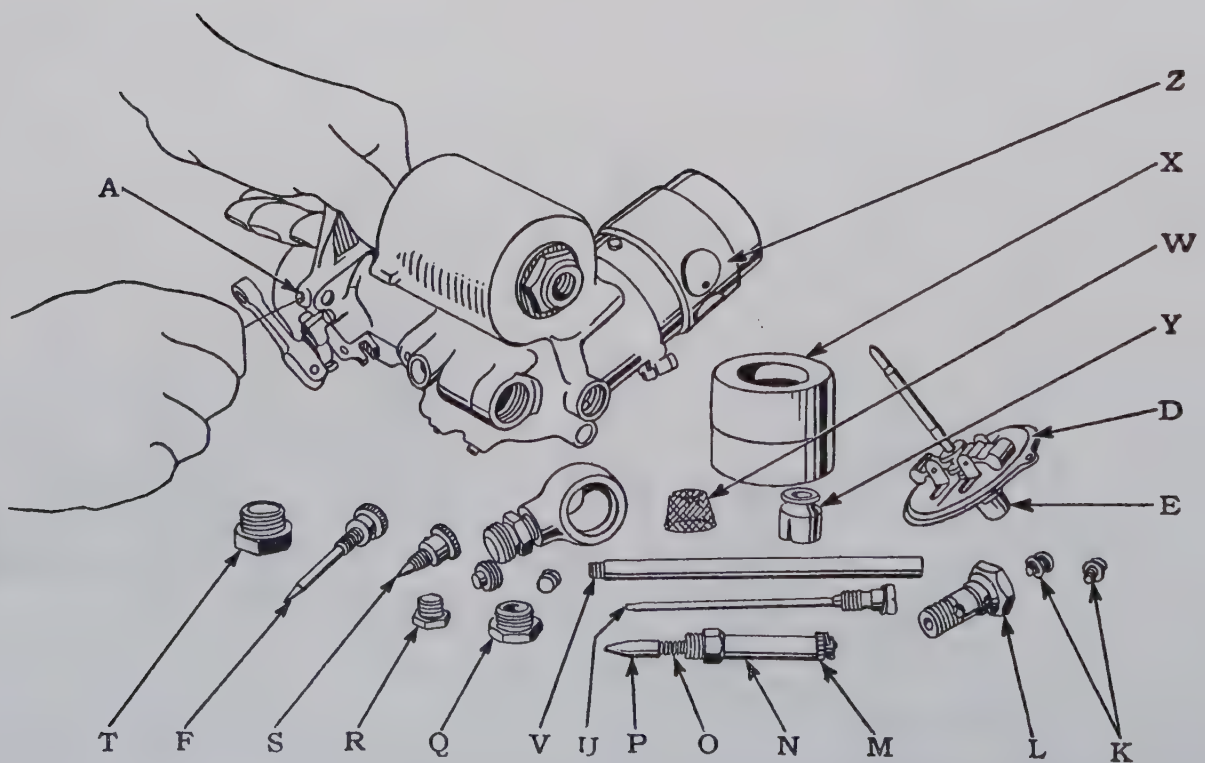
Correct Way to Assemble Butterfly Valve (Showing Mark on Valve Which Should Be Next to Idling Jet "C")

Illus. No. 84
Adjusting Float Level (Stromberg)

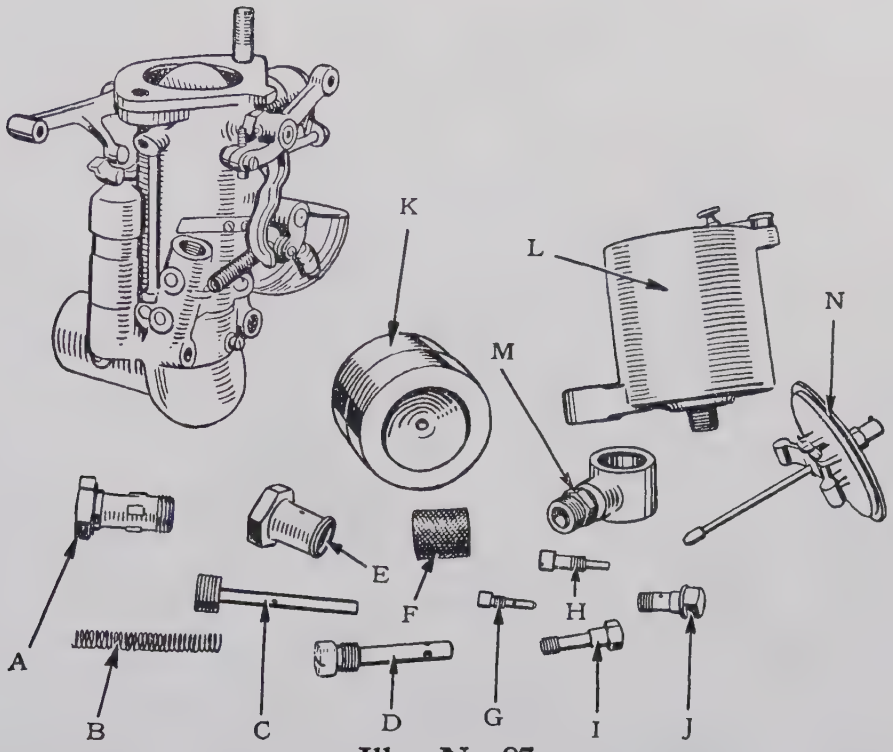
Illus. No. 83
Removing Float Valve Cover and Needle Assembly. (Stromberg)



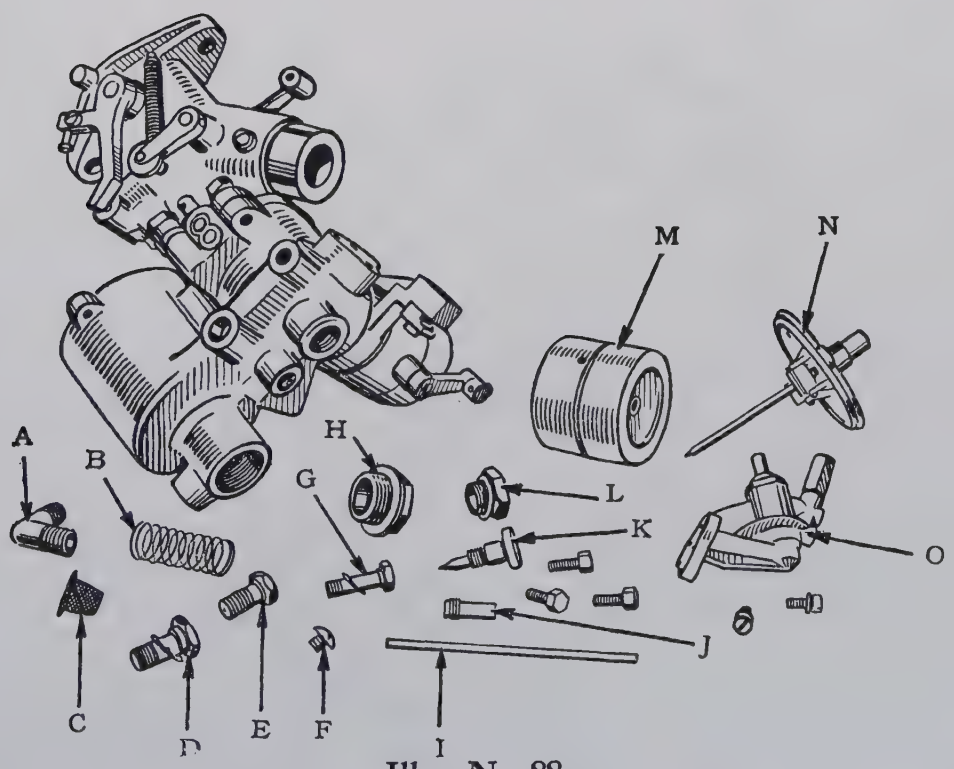
Illus. No. 85
Float Needle Removed (Stromberg)



Illus. No. 86
Cleaning Stromberg Carburetor

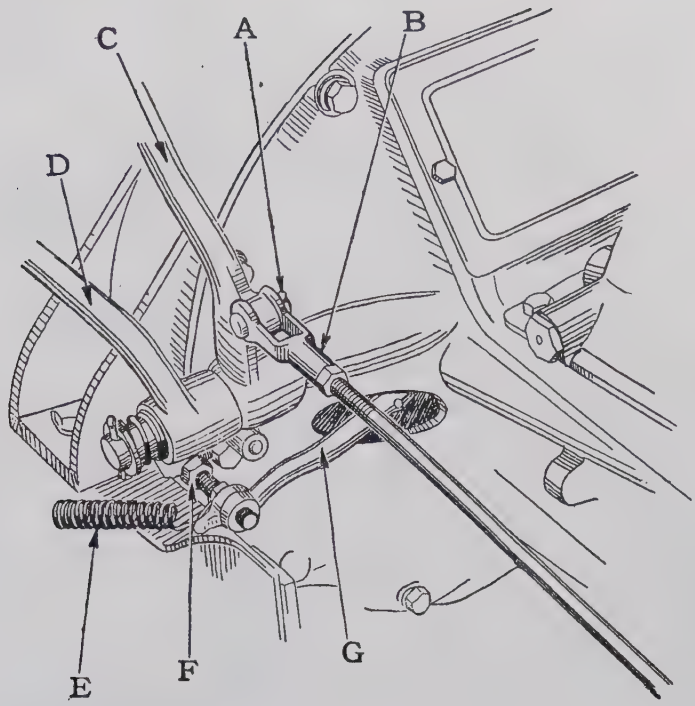


Illus. No. 87
Ball and Ball Carburetor, Disassembled For Cleaning



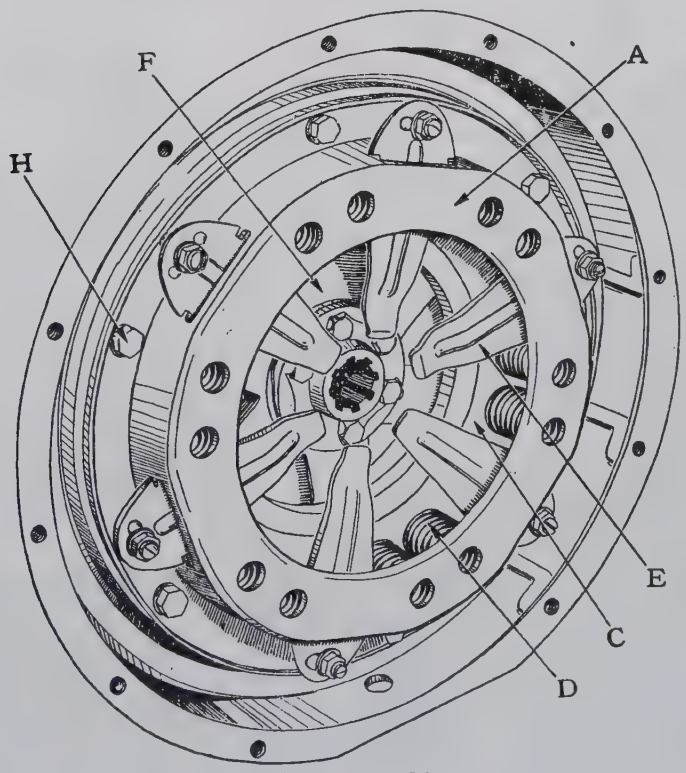
Illus. No. 88
Ball and Ball Carburetor, Model SV-33— Disassembled For Cleaning

Issued October 15, 1927
Insert in Volume Three, after page 108.



Illus. No. 89

Clutch and Brake Pedal Adjustments
(Long Clutch—Mechanical 4-Wheel Brakes)



Illus. No. 90

Clutch Assembled in Engine
(Long Clutch)

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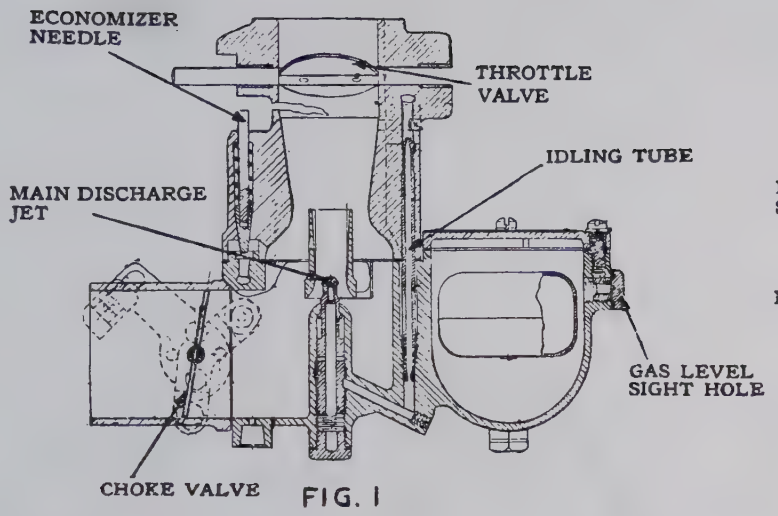


FIG. 1

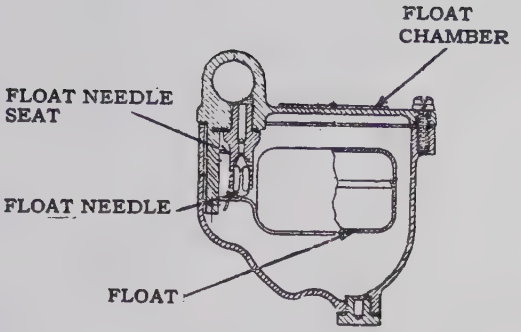


FIG. 2

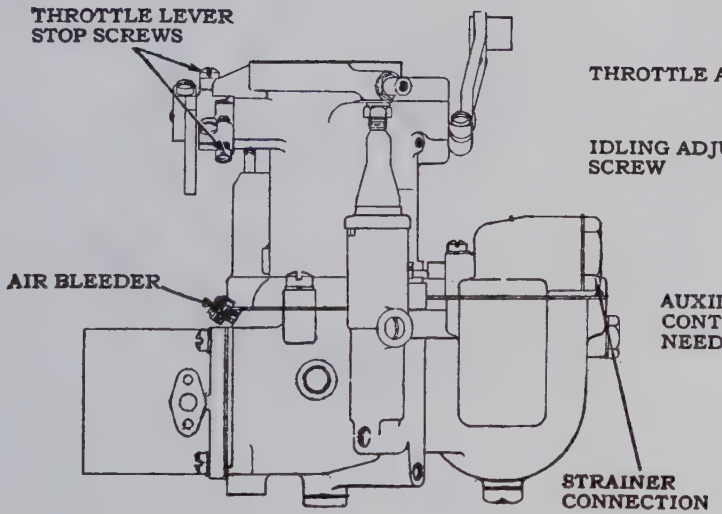


FIG. 3

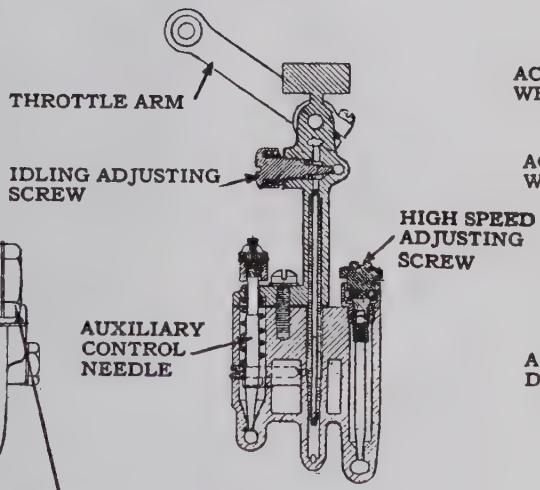


FIG. 4

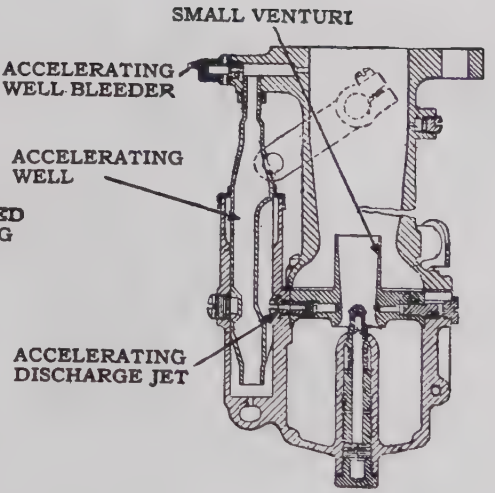
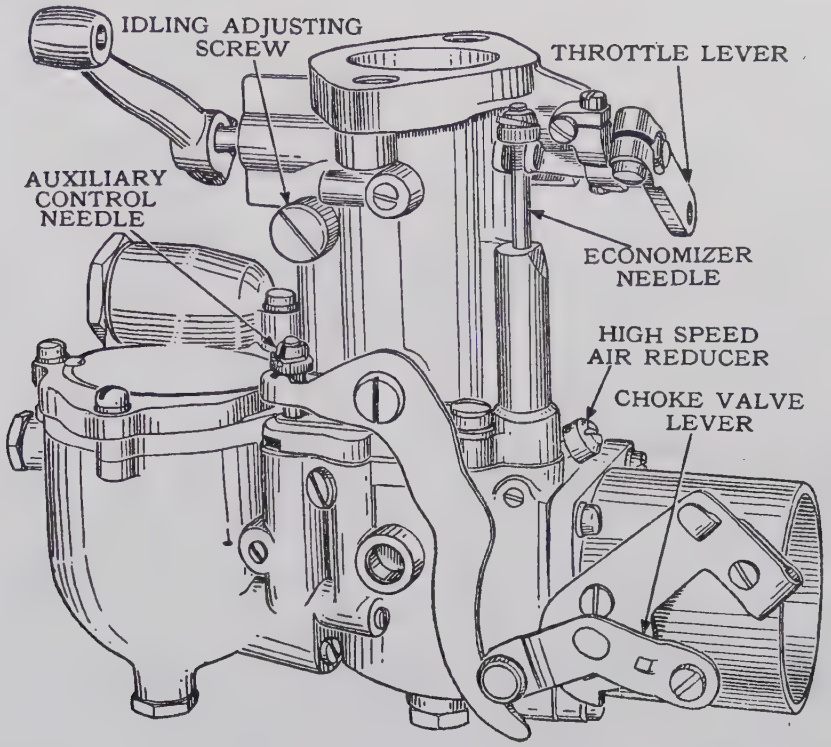


FIG. 5

Illus. No. 91

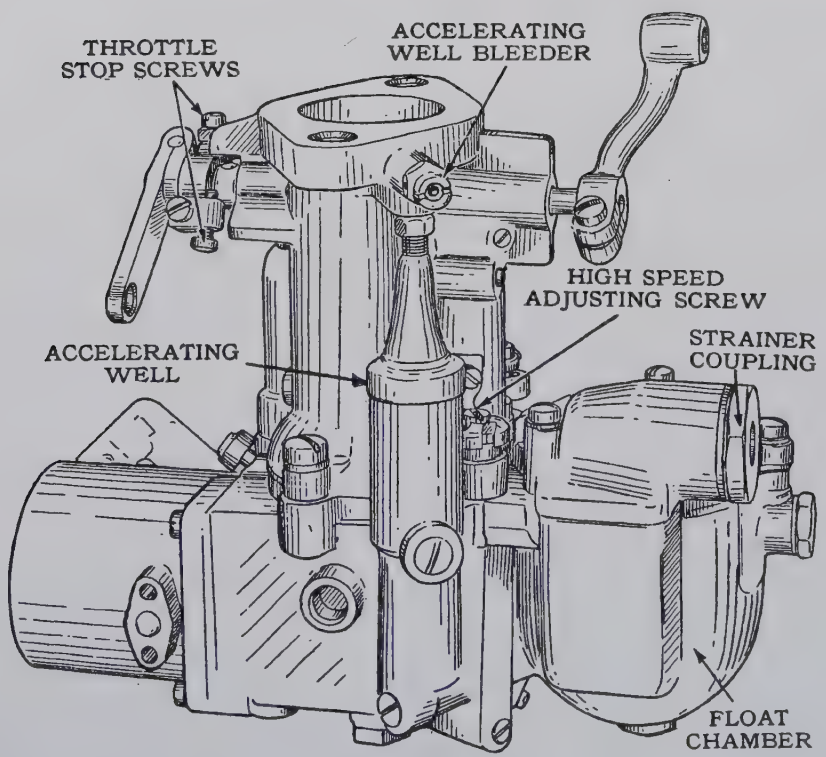
Sectional views of Stromberg Carburetor, Model TX-2
(Used on Big Six Commander Models)

Issued October 15, 1927
Insert in Volume Three, after page 108B.



Illus. No. 92

Stromberg Carburetor, Model TX-2
(Commander Models)



Illus. No. 93

Stromberg Carburetor, Model TX-2
(Commander Models)

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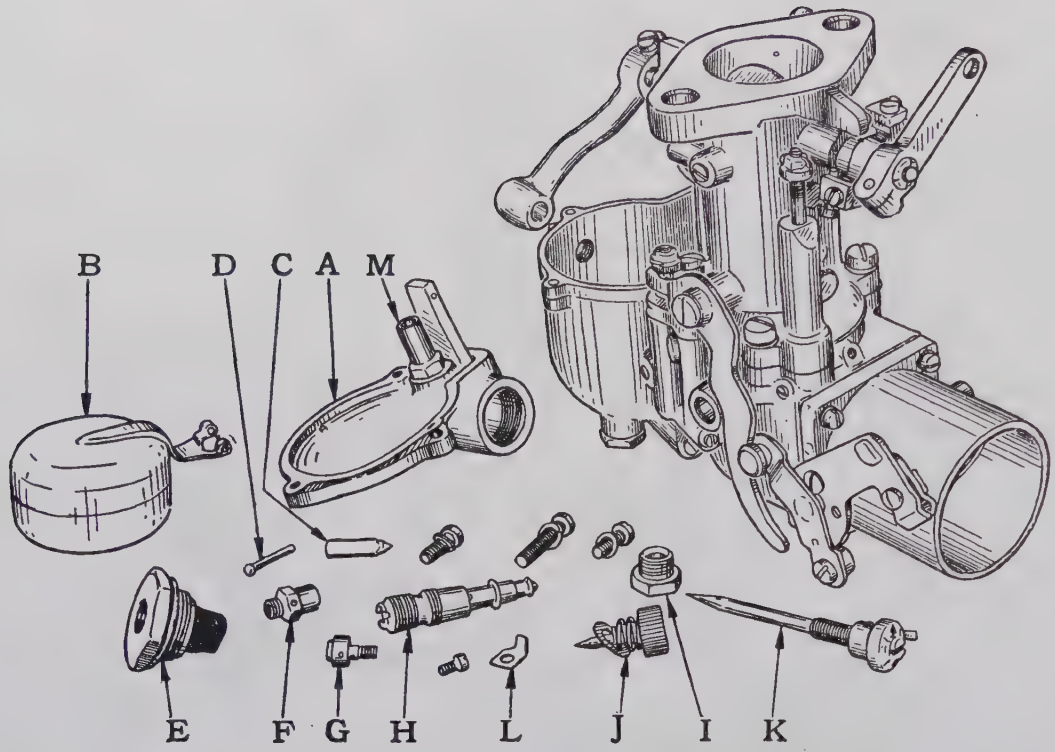

Illus. No. 94

Stromberg Carburetor—Disassembled for Cleaning
(Model TX-2)

OPERATION ARTICLES

The following section is one containing instructions for disassembling, assembling and repairing various units. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised operation will be carried at the bottom of the green sheets.

For example, the reader is interested in Operation Article No. 3, To Remove and Replace Cylinder Head. Before he reads this, a glance at the bottom of the page will tell whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the Operation Article No. 3, such as 3-1 or 3-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ARTICLE No. 1

To Remove and Replace Intake Manifold, Vacuum Tank and Carburetor Assembly

1. Turn off nut "Y" (Illus. No. 6) connecting the gasoline pipe with the top of the vacuum tank. Also remove nut "Z" (Illus. No. 6) connecting the suction line with the intake manifold.

2. Loosen the two clamp screws "X" and "W" holding the choke control tube and choke wire to the carburetor (Illus. No. 6). The tube and wire can now be disconnected from the carburetor.

3. Remove the nut connecting the carburetor feed pipe "V" with the carburetor and drain the gasoline from the vacuum tank.

4. Remove outer nut at the right side of the intake manifold holding one side of the vacuum tank bracket.

5. Remove the two screws "B" and remove the vacuum tank.

6. Disconnect the hand throttle connected at "F" and the foot accelerator connected at "E."

7. Remove the four nuts "J" holding the intake manifold hot spot section "I" to the exhaust manifold.

8. Remove the four bolts "H" holding the intake manifold hot spot section "I" to the lower section and remove the hot spot section with the carburetor.

9. Remove the two nuts "L" holding the manifold clamps at either end of the manifold.

10. Remove the two center nuts holding the lower intake manifold to the cylinder. The lower intake manifold can now be removed.

11. Reverse operations to replace. Make sure that all gaskets and the cylinder block aligning rings are in good condition and properly placed.

Tools Required—No. 23 and 27 open end wrenches, 9/16 inch socket wrench, pliers, screw driver.

ARTICLE No. 2

To Remove and Replace Exhaust Manifold

1. Remove the intake manifold, carburetor and vacuum tank assembly, (See Operation Article No. 1).

2. Remove the two bolts "T", holding the exhaust manifold to the air cleaner or exhaust pipe flange (Illus. No. 6).

3. Loosen the nut "R" and remove the air cleaner if the car is equipped with one.

4. Remove the two exhaust manifold center bolts holding the manifold to the cylinder block. The manifold is then free to be removed.

5. Reverse operations to replace. Make sure that all gaskets and cylinder block aligning rings are in good condition and properly placed.

Tools Required—No. 23 and 27 open end wrenches, 9/16 inch socket wrench, pliers and screw driver.

ARTICLE No. 3

To Remove and Replace Cylinder Head

1. Drain the radiator and remove the hood.

2. Loosen the hose clamp at the water header and remove the hose from the header.

3. Remove the distributor cover.

4. Remove the cylinder head stud nuts or cap screws shown in Illus. No. 17.

5. Lift off the horn and bracket assembly.

6. The cylinder head can now be removed. (See Illus. No. 27).

Tap the head with a lead or rawhide hammer to loosen it from the studs and then lift evenly.

DO NOT PRY UNDER CYLINDER

HEAD. THIS MAY DAMAGE THE HEAD OR GASKET.

A boss is provided at the front of the cylinder head for lifting.

7. Remove the gasket carefully to avoid tearing any holes when lifting over the studs.

8. To reassemble reverse operations.

Inspect the gasket carefully to see that the asbestos is not broken or torn out at any point and also see that the copper flanges surrounding the openings form a firm juncture with the copper sheets. It is usually advisable to use a new gasket. However, if the one removed is in exceptionally good condition it may be used again.

Exercise care in placing the gasket over the studs and put the beaded side of the gasket next to the cylinder head.

Replace the cylinder head and screw the nuts or cap screws on by hand. Then partially tighten them in the order shown in Illus. No. 17, afterwards drawing them tight in the same order. It is advisable to further tighten them after the engine has been run sufficiently to warm it up.

Tools Required—No. 27 open end wrench or cylinder head nut wrench C. O. 265, screw driver, pliers, hammer.

ARTICLE No. 4

To Grind Valves

1. Remove the valve cover plate.

2. Remove the cylinder head and gasket. (See Operation Article No. 3).

3. Remove all carbon from the top of the cylinders and pistons, using an electric drill and wire brush.

4. Lift the valve spring retainers and remove the retainer pins "A" (Illus. No. 46).

5. Remove the valves, making sure that they are properly marked so that they can be replaced in the original position.

6. Clean all carbon from the valve heads and stems. If the stems are rough or corroded, clean them with fine emery cloth and oil, or if badly corroded or warped, replace them with new valves.

7. If the valve faces are pitted or grooved, they must be refaced. (See C. O. 51, Vol. 8).

8. Apply the reamer C. O. 52, (See Vol. 8.) to the valve seats, being careful to remove only enough to clean up the seats leaving a smooth surface. Always use the reamer when grinding valves as it will shorten the grinding operation.

9. Place a small amount of grinding compound on the valve face.

10. Replace the valve using a light coil spring under the head (spring should have sufficient tension to raise the valve off the seat) and turn down the push rod adjusting screws "A" (Illus. No. 47) to insure clearance under the end of the valve stems.

11. Oscillate the valve with only slight pressure. Relieve the pressure on the valve occasionally to allow the compound to work around the seat and give a more uniform surface.

Continue the grinding operation only until the valve and its seat show a perfect bearing. If operations 7 and 8 have been properly done, little grinding will be necessary.

Test the valve by placing a very light coating of Prussian Blue on the valve face and turning it one quarter turn in its seat. If the seat shows a clear, clean line of blue, the valve is seating properly. If there are points where the blue does not touch, the valve has not been ground enough.

12. Wash the valves and seat thoroughly with gasoline.

Blow out all loose particles of carbon or grinding compound from the cylinders and valve chambers.

THIS CLEANING OPERATION IS VERY IMPORTANT.

13. To reassemble reverse operations.

Before replacing the cylinder head clean out all carbon with an electric drill and wire brush. Polish the combustion chamber thoroughly.

14. After the valves have been completely assembled in the engine, adjust the tappets. (See Operation Article No. 6).

Tools Required—Cylinder head nut wrench, C. O. 265, valve spring compressor, C. O. 134, valve lathe C. O. 51, valve seat reamer C. O. 52, valve grinding tool C. O. 127, adjusting wrenches C. O. 250, 251 and 252, thickness gauge, grinding compound, Prussian Blue, No. 23 and 27 open end wrenches, 9/16 inch socket wrench, screw driver, pliers and hammer.

ARTICLE No. 5

To Install New Valve and Guide

1. Remove the valve cover plate.
2. Remove the cylinder head and gasket. (See Operation Article No. 3).
3. Lift the valve spring retainer and remove the retainer pin "A" (Illus. No. 46) on the valve to be removed.
4. Remove the valve and spring.
5. Drive out the old guide.
6. Pull in the new guide using puller C. O. 70, Illus. No. 45. (See instructions in Vol. 8).
7. Ream the guide to size with the special reamer C. O. 97. Wash and blow out the guide carefully after reaming.
8. Ream the valve seat to line up with the new guide (See C. O. 52, Vol. 8).
9. Grind in the valve. (See Article No. 4, operations 10 to 13 inclusive).
10. Reverse operations to assemble.

Tools Required—Cylinder head nut wrench C. O. 265, valve spring compressor C. O. 134, valve guide installing fixture C. O. 70, valve guide reamer C. O. 97, adjusting wrenches C. O. 250, 251 and 252, thickness gauge, No. 23 and 27 open end wrenches, 9/16 inch socket wrench, screw driver, pliers, brass drift, hammer, valve seat reamer C. O. 52, valve grinding tool C. O. 127.

ARTICLE No. 6

To Adjust Valve Tappets

1. Start the engine and allow it to run until warm.
2. Remove the valve cover plate.
3. Open the priming cup or remove the spark plug on No. 1 cyclinder and turn the engine with the crank until No. 1 piston is coming up on the compression stroke. This will be evidenced by the escape of compression at the opening. With the engine in this position the intake and exhaust valves on No. 1 cyclinder will both be closed.
4. Loosen the tappet adjusting screw lock nut "B" as shown in Illus. No. 47, hold the tappet "C" and turn the adjusting screw "A" up or down until a clearance of .006 of an inch is obtained between the valve stem and the adjusting screw on passenger cars and .006 of an inch on intake and .010 of an inch on exhaust valves of busses. Use a feeler gauge to determine the clearance.
5. Tighten the adjusting screw lock nut "B", at the same time holding the adjusting screw "A" to prevent it from slipping.
6. After No. 1 intake and exhaust valves have been properly adjusted, close No. 1 priming cup, open No. 5 and turn the engine as before. The valves on No. 5 cylinder will then be in position to adjust, and so on in the proper firing order 1-5-3-6-2-4. By taking them in this order, the whole set of tappets can be adjusted in two revolutions of the engine.

The tappet adjustment should not be made with a view of gaining extreme quietness at this point, but to obtain the quietest possible adjustment with the minimum given.

7. Replace the valve cover plate.

Tools Required—No. 25 open end wrench, pliers, feeler gauge, tappet adjusting wrenches C. O. 250, 251 and 252.

ARTICLE No. 7

To Remove and Replace Push Rod and Guide

1. Remove the valve cover plate.
2. Loosen the push rod adjusting screw lock nut "B" (Illus. No. 47) and turn the adjusting screw "A" down as far as possible.
3. Remove the nut "A" (Illus. No. 48) holding the push rod guide clamp "B". Then remove the clamp and spacer "C".
4. Lift the valve, using a block of wood and pry bar as in Illus. No. 43.
5. Lift out the push rod and guide.

Revised October 15, 1927
Insert in Volume Three, in place of original page 113.
PRINTED IN U. S. A.

6. Reverse operations to assemble.

Care should be taken to see that the spacer "C" (Illus. No. 48) is placed between the clamp "B" and the cylinder block and that the nut "A" is drawn tight with the lock washer under it. The clamp must be installed with the arch up.

See Article No. 6 to adjust the tappet clearance.

Tools Required—No. 29 open end wrench, tappet adjusting wrenches C. O. 250, 251 and 252, thickness gauge, pliers, wood block, pry bar.

ARTICLE No. 8

To Remove and Replace Radiator Assembly

1. Open the drain cock under the water pump and drain the radiator.
2. Remove the hood.
3. Loosen the upper radiator hose clamp on the water header.
4. Loosen the lower radiator hose clamp on the radiator.
5. Pull the split pins and turn off the two nuts holding the radiator to the frame cross member.
6. Disconnect the front end of the radiator brace rods.
7. The radiator assembly can now be lifted from the car.
8. Reverse operations to assemble. Make sure that the washers are placed between the radiator and the frame cross member. Do not tighten the radiator in place until the hood has been replaced so the radiator can be shifted slightly, if necessary, to line up with the hood.

Tools Required—No. 25 and 27 open end wrenches, screw driver and pliers.

ARTICLE No. 9

To Disassemble and Assemble Radiator Assembly

1. Remove the radiator. (See Operation Article No. 8).
2. Remove the fourteen bolts holding the radiator shell and core together.
3. Remove the filler cap.
4. The core can now be removed.
5. Reverse operations to assemble. If the ledge filler strip is worn, use a new one.

Tools Required—No. 25 and 29 open end wrenches, screw driver, pliers.

ARTICLE No. 10

To Remove and Replace Fan Assembly and Belt

The first six operations are to be used for fans on engines before Big Six 11534 *and Special Six* 36270.

1. Loosen lock nut "E" on adjusting screw "B" (Illus. No. 15).
2. Turn out adjusting screw "B" several turns to loosen the fan belt.
3. Slide the fan and support assembly off of the support stud.

If the belt only is being replaced, it is not necessary to slide the fan support off of the stud.

4. Slide the fan belt over the support and remove the fan.
5. Remove the fan belt from the lower pulley.
6. Reverse operations to assemble.

After the fan and belt have been replaced, turn adjusting screw "B" (Illus. No. 15), clockwise or to the right until the belt is just tight enough to drive the fan without slipping. Do not draw it too tight.

Tighten lock nut "E" after the belt has been adjusted.

The following operations are to be used on the self-adjusting fan which started with engine numbers, Big Six 11534 *and Special Six* 36270.

1. Unscrew the fan belt adjusting wing nut "B" (Illus. No. 12).
2. Slide the fan belt off of the lower pulley.
3. Loosen the clamp bolt "S" (Illus. No. 8).
4. The fan assembly can now be removed by sliding the fan spindle out of the bracket arm.
5. Reverse operations to assemble.

Tighten the adjusting wing nut so that, with the engine not running, it requires reasonable difficulty to turn the fan by hand.

Tools Required—Pliers, screw driver, No. 21 and 27 open end wrenches.

ARTICLE No. 11

To Disassemble and Assemble Fan

The following operations are for use only when disassembling the fan used previous to engine numbers, Big Six 23824 *and Special Six* 49894. *If disassembling later type fan refer to Operation Article No.* 12.

1. Remove the fan assembly. (See Operation Article No. 10).

Use operation No. 2 *and omit operation No.* 8 *if disassembling the self-adjusting fan.*

2. Remove the clamp bolt "S" (Illus. No. 9) and drive out the fan spindle using a brass drift and hammer. Clamp the end of the spindle in a vise.
3. Unscrew and remove the fan bearing cone lock nut "K" (Illus. No. 30) which has a right hand thread.
4. Pull off the fan bearing cone dust cap "J".
5. Unscrew and remove the fan bearing cone adjusting nut "I" (Illus. No. 30). The adjusting nut has a left hand thread.
6. Remove the front bearing and cone "H" and pull the fan off of the spindle.
7. Slide the rear bearing "D" and cone "B" off of the spindle.
8. Hold the fan support securely in a vise and unscrew the spindle.
9. Reverse operations to assemble.

To adjust the fan bearings, adjust the front cone on the spindle by means of adjusting nut "I" so that the fan spins freely but has no play in the bearings.

Tools Required—No. 31, 33 and 21 open end wrenches, adjustable wrench, pliers, screw driver, brass drift, hammer.

ARTICLE No. 12

To Disassemble and Assemble Fan

The following operations are to be used only when disassembling the fan which started with engine numbers, Big Six 23824 *and Special Six* 49894. *See Operation Article No.* 11 *for instructions on previous type fans.*

1. Remove the fan assembly. (See Operation Article No. 10).
2. Remove the bolts holding the fan blades "B" (Illus. No. 31) to the fan body and remove the blades.
3. The fan spindle "D" can now be pulled out of the fan body.
4. Unscrew the thrust plate "C" from the fan spindle, which has a right hand thread.
5. If necessary to remove the cork gasket and retainer "E" at the pulley end of the fan body, this can be pried out with a screw driver.
6. Reverse operations to assemble.

After screwing the thrust plate "C" (Illus. No. 31) onto the fan spindle make sure to peen the plate into the slot which is cut in the threaded portion of the fan spindle "D".

If the fan shows any indication of leaking oil it is advisable to install new cork gaskets.

Make sure that none of the fan blades obstruct the oil hole when assembling the blades to the fan body.

Tools Required—Screw driver, pliers, pipe wrench, center punch, hammer.

ARTICLE No. 13

To Remove and Replace Starter Clutch and Vibration Damper

1. Remove the radiator. (See Operation Article No. 8).

2. Unscrew the starting crank spindle "F" (Illus. No. 9). This can be removed with a large adjustable wrench.

3. Crowd the fan belt off the starter clutch pulley.

4. Take out the starter chain master link "C" and remove the chain.

5. Remove the four screws "B" (Illus. No. 13). This will permit removing the fan drive pulley, leaving the four other screws "A" to hold the vibration damper and starter clutch together.

6. Pull the starter clutch assembly as shown in Illus. No. 54. (See instructions on puller under C. O. 71, Vol. 8).

7. Remove the starter clutch housing key.

8. Slide off the starter clutch sprocket bushing.

9. Reverse operations to reassemble.

Tools Required—Screw driver, adjustable wrench, universal puller C. O. 71, No. 27 open end wrench, pliers, punch and hammer.

ARTICLE No. 14

To Disassemble and Assemble Starter Clutch

1. Remove the starter clutch and vibration damper. (See Operation Article, No. 13).

2. Remove the 8 screws "M" (Illus. No. 57) holding the starter clutch cover to the housing.

3. The housing "G" (Illus. No. 56) can now be lifted off. Care must be taken to prevent the pawls, "A", "B" and "C", plungers "D", "E" and "F" and springs from being lost.

4. Reverse operations to assemble, first making sure that the housing cover gasket is in good condition. Then place the springs, plungers and pawls in position as shown in Illus. No. 58. Place the housing over two of the pawls and push the third pawl toward the plunger as far as possible with the fore finger (Illus. No. 59). While turning the housing clockwise, raise the low side slowly until the housing drops into place. Replace the screws holding the cover to the housing.

Tools Required—Screw driver, adjustable wrench, universal puller C. O. 71, No. 27 and 25 open end wrenches, pliers, punch and hammer.

ARTICLE No. 15

To Disassemble and Assemble Vibration Damper

1. Remove the starter clutch and vibration damper (See Operation Article No. 13).

2. Remove the four screws "A" (Illus. No. 13).

3. The damper can now be disassembled as shown in Illus. No. 55.

4. In assembling, place the starter clutch assembly "A" (Illus. No. 55) on the bench and assemble the damper parts to it in the order lettered, starting with the disc "B". Make sure that the four dowel pins and springs are in place between the damper flywheel plates. Replace four of the fastening screws and tighten them evenly. The other four screws are not to be put in until the assembly is back on the engine and the fan pulley is ready to be replaced. (See Operation Article No. 13).

When putting on ring "F" (Illus. No. 55) be sure to place it so that the oil groove "H" in the ring lines up with the oil hole "I" in the starter clutch housing.

Tools Required—Screw driver, pliers, adjustable wrench, universal puller C. O. 71, No. 21, 25 and 27 open end wrenches, punch and hammer.

ARTICLE No. 16

To Remove and Replace Starter Motor

1. Turn off the two cable nuts on side of the starter motor and remove the cables.
2. Remove the lock in the master link of the chain shown at "C" (Illus. No. 9).
3. Take out the master link in the chain and lift the chain off of the starter sprocket.
4. Loosen the starter motor clamp screw 'B".
5. Remove the cotter pin from pin "A" holding the starter motor to the crank case.
6. Drive out pin "A".
7. The starter motor can now be removed.
8. Reverse operations to replace.

Tools Required—Pliers, screw driver, No. 27 open end wrench, starter fastening screw wrench C. O. 256.

ARTICLE No. 17

To Remove and Replace Generator

1. Disconnect the wire at the side of the generator.
2. Turn out the three cap screws "V" (Illus. 9) holding the generator in place.
3. Turn off nut "U", holding the generator to the bracket.
4. Loosen cap screw "T" holding the bracket to the cylinder block.
5. The generator can now be removed.
6. Reverse operations to replace, making sure the rubber bumpers are not cramped as in Illus. No. 14, and that the generator base sets flat on the bracket before tightening the fastening screws.

Tools Required—No. 25 open end wrench, pliers, 9/16 inch socket wrench.

ARTICLE No. 18

To Remove and Replace Ignition Distributor

If the car being worked on is not equipped with the self-adjusting fan, omit operations No. 1, 2 and 7.

1. Unscrew the fan belt adjusting wing nut "B" (Illus. No. 12).
2. Slide the fan belt off of the lower pulley.
3. Remove the distributor cap leaving the cables assembled.
4. Disconnect the distributor to ignition coil cable.
5. Remove the two screws "R" as shown in Illus. No. 9.
6. The distributor can now be removed. See that none of the shims located at the bottom of the distributor bracket are lost.
7. Pull the cotter pin, unscrew nut "A" (Illus. No. 12) and remove the fan.
8. Reverse operations to assemble.
9. To check the backlash between the distributor gears on Wagner distributors, remove the following parts before bolting the distributor support in position for the test. Remove the distributor rotor and take out the screw holding the cam. Pry the cam off of the shaft with a screw driver. Remove the four screws and lift off the top of the distributor. Unhook the two weight springs and lift out the distributor cam shaft. Now bolt the distributor support to the engine with the shims in place. Test the backlash by attempting to turn the distributor shaft as shown in Illus. No. 10. Remove or add shims, if necessary, to allow a slight movement of the shaft with the support screws drawn tight. When the correct backlash has been obtained, remove the support to assemble the part to it.

To check the backlash on Remy distributors, bolt the distributor assembly to the engine with the shims in place. Remove the distributor rotor

and unscrew the nut holding the cam. Pry the cam off of the shaft with a screw driver. Remove the two screws holding the base plate and lift off the plate. Unhook the two weight springs and lift out the distributor cam shaft. Check for backlash as above.

10. Time the spark. (See Operation Article No. 17, Vol. 7, or use following operations):

A. Open the priming cup on No. 1 cylinder and crank the engine by hand until No. 1 piston has begun its compression stroke, which can be detected by holding the thumb over the priming cap until compression is felt.

B. Continue to crank the engine until the mark "UP-DC-1-6" on the flywheel comes under the timing pointer in the left-hand side of the flywheel housing.

C. Loosen the screws on Wagner equipment or the nut on Remy equipment which holds the cam on the tapered shaft.

D. Pry up the cam with a screw driver.

E. Turn the cam in a counter-clockwise direction until it reaches a position such that when all parts are assembled, the edge of the rotor segment comes directly under No. 1 distributor cover terminal and the breaker points are just in the act of breaking.

F. Tighten the lock screw or nut in this position and replace the rotor and distributor cover.

G. The firing order is 1-5-3-6-2-4. See that the wires leading to the spark plugs follow No. 1 in that order, in a counter-clockwise direction around the distributor cap.

Tools Required—Pliers, screw driver, No. 21, 25 and 27 open end wrenches.

ARTICLE No. 19

To Remove and Replace Gear Case Front Cover and Water Pump Assembly

1. Remove the starter clutch and vibration damper. (See Operation Article No. 13).

2. Remove the fan. (See Operation Article No. 10).

3. Take out the two front cap screws in the upper gear case cover.

4. Turn out the water pump drain pipe at the bottom of the water pump body.

5. Take out the eight cap screws "K" (Illus. No. 9) holding the gear case cover to the crank case.

6. Loosen the water pump to cylinder block hose upper clamp.

7. The cover, gasket and water pump assembly can now be removed.

8. Reverse operations to assemble using a new gasket.

Tools Required—Screw driver, adjustable wrench, universal puller C. O. 71, No. 21, 25 and 27 open end wrenches, punch, hammer, pliers.

ARTICLE No. 20

To Disassemble and Assemble Water Pump

1. Remove the gear case front cover and water pump assembly. (See Operation Article No. 19).

2. Turn out the six cap screws "J" (Illus. No. 64) holding the water pump body to the gear case cover.

3. Remove pump body "I" (Illus. No. 64).

4. Remove the nut holding pump gear "E" to the shaft.

5. Remove the gear using Universal Puller C. O. (See Vol. 8) and remove the key.

6. Unscrew the water pump packing nut "H". This has a left hand thread.

7. Pull out the impeller and shaft assembly.

8. Drive out the impeller pin, knock off the impeller and remove the key. (See the pump completely disassembled in Illus. No. 65).

9. Reverse operations to reassemble.

Tools Required—Screw driver, adjustable wrench, universal puller C. O. 71, No. 25 and 29 open end wrenches, punch, hammer and pliers.

ARTICLE No. 18-1

To Remove and Replace Ignition Distributor

The following revision in Article No. 18 *operation* 10, *applies to Big Six cars equipped with the manual spark control on the instrument board.*

10. To time the spark. (See Operation Article No. 17-1, Vol. 7 or use the following operations:)

A. Remove the spark plug from No. 1 cylinder and crank the engine over by hand until No. 1 piston has begun its compression stroke, which can be detected by holding the thumb over the opening until the compression is felt.

B. Continue to crank the engine until the mark "UP-DC-1-6" on the flywheel comes under the pointer in the left side of the flywheel housing.

C. Remove the distributor cover without disconnecting the wires. With the spark lever on the instrument board set in a halfway position between the advance and retard marks, the rear edge of the spark control arm should be lined up with the mark on the distributor housing. If the control arm does not line up with this mark, loosen the set screw which fastens the spark control wire at the distributor and move the arm until it lines up with the mark and tighten the set screw.

D. Loosen the lock nut which holds the cam on the tapered shaft and pry up the cam with a screw driver.

E. Turn the cam in a counter-clockwise direction until it reaches such a position that when all parts are assembled, the edge of the rotating segment comes directly under No. 1 distributor cover terminal and the breaker points are just in the act of breaking.

F. Tap the cam down and tighten the lock nut. Replace the distributor cover.

Tools Required—Screw driver, pliers, No. 21, 25 and 27 open end wrenches.

Issued October 15, 1927
Insert in Volume Three, after page 118.

PRINTED IN U. S. A.

ARTICLE No. 21

To Remove and Replace Gear Case Upper Cover

1. Remove the fan. (See Operation Article No. 10).
2. Remove the distributor. (See Operation Article No. 18).
3. Remove the generator. (See Operation Article No. 17).
4. Turn out the five cap screws and one flat head screw holding the upper cover to the crank case and the front cover.
5. The cover can now be removed.
6. Reverse operations to assemble, using a new gasket.

After completing the operations, time the distributor as directed in Operation Article No. 18, operation 10.

Tools Required—No. 21 and 25 open end wrenches, 9/16 inch socket wrench, large screw driver.

ARTICLE No. 22

To Remove and Replace Cam Gear

1. Remove the gear case front cover and water pump assembly. (See Operation Article No. 19).
2. Remove the gear case upper cover, (See Operation Article No. 21).
3. Turn out the cap screw "C" (Illus. No. 11) holding the distributor drive gear "D" and remove the gear. This is done by inserting a 3/8 inch rod in the hole in the gear and prying it out.
4. Pull the cam gear with Universal Puller C. O. 71, (Illus. No. 44) (See also C. O. 71, Vol. 8).
5. Reverse operations to assemble.

Press the cam gear on with cam gear installing Puller C. O. 71. (See Vol. 8).

Make sure that the tooth marked "O" on the crank gear meshes between the two teeth marked "O" on the cam gear at "H" (Illus. No. 11).

After completing the operations, time the distributor as directed in Operation Article No. 18, operation 10.

Tools Required—No. 21, 25 and 27 open end wrenches, screw driver, pliers, adjustable wrench, Universal Puller C. O. 71, punch, hammer, 9/16 inch socket, cam gear installing fixture C. O. 423.

ARTICLE No. 23

To Remove and Replace Crankshaft Gear

1. Remove the gear case front cover and water pump assembly. (See Operation Article No. 19).
2. Pull the crankshaft gear with Universal fixture C. O. 423. (See Vol. 8).
3. Reverse operations to assemble.

When replacing the gear make sure that the tooth marked "O" on the crankshaft gear meshes between the two teeth marked "O" on cam gear at "H" (Illus. No. 11).

Tools Required—No. 21, 25 and 27 open end wrenches, screw driver, pliers, adjustable wrench, Universal Puller C. O. 71, punch, hammer, 9/16 inch socket.

ARTICLE No. 24

To Remove and Replace Camshaft and Gear Assembly

1. Remove the cam gear. (See Operation Article No. 22).
2. Lift all the valves and block up the push rods with lock washers as shown in Illus. No. 49.

3. Remove the front camshaft bearing set screw which is located just above the bearing in the crankcase.

4. The camshaft and front bearing can be removed as shown in Illus. No. 49.

The camshaft should be handled with extreme care to avoid damaging any of the cam or bearing surfaces.

5. Reverse operations to assemble.

After the camshaft is in place, press the gear on using cam gear installing fixture C. O. 423. (See Vol. 8.)

Make sure that the tooth marked "O" on the crankshaft gear meshes between the two teeth marked "O" on the cam gear at "H" (See Illus. No. 11).

After completing the operations time the distributor as directed in Operation Article No. 18, operation 10.

Tools Required—No. 21, 25 and 29 open end wrenches, screw driver, pliers, adjustable wrench, Universal Puller C. O. 71, cam gear installing fixture C. O. 423, punch, hammer, 9/16 inch socket wrench.

ARTICLE No. 25

To Check Valve Timing

1. Check the flywheel to see if it is properly assembled to the crankshaft. (See the following operations).

A. Remove No. 1 spark plug and turn the engine slowly by hand until No. 1 piston is at the top of the cylinder, which can be observed through the spark plug hole. The mark "UP-DC-1-6" on the flywheel should now be under the timing pointer (or nearly so) in the left-hand side of the flywheel housing (Illus. No. 18).

B. If the mark is not visible through the timing hole, turn the flywheel slowly backward or forward to locate the position of the mark. If the flywheel has been improperly assembled to the crankshaft flange the mark will be *at least* 1/6 of a revolution or 8⅜" from the pointer, as shown in Illus. No. 16. If it is not properly assembled, new marks must be made on the flywheel before the timing can be checked.

C. In locating the new marks, the first operation is to determine whether the flywheel is off position 1/6, 1/3 or 1/2 revolution. See Illus. No. 16 and note that there are 5 positions in which the flywheel may be incorrectly assembled.

D. After determining in which position the flywheel is incorrectly assembled, bring the mark "UP-DC-1-6" stamped on the flywheel, under the timing pointer. (Illus. No. 18).

Then, turning the flywheel in the direction of rotation, measure on the face of the flywheel the exact distance given in Illus. No. 16 in whichever Figure applies to the position of the flywheel.

Thus, if the flywheel is 1/3 revolution off, 16 3/4" would be measured on the face of the flywheel as shown in Illus. No. 16.

E. After the dead center position has been thus marked continue to turn the flywheel and measure 1 3/64" more, as shown in Illus. No. 16. Scribe a second mark here which will represent the mark "IN-OP-1-6." Now replace the No. 1 spark plug and proceed with the following operations.

2. Remove the valve cover plates.

3. Crank the engine by hand, with the finger over the open priming cup in No. 1 cylinder, until compression is felt. Then continue to crank the engine slowly until the mark "UP-DC-1-6" on the flywheel is under the timing pointer.

4. Both valves for No. 1 cylinder are now closed. Loosen the push rod adjusting screw lock nut "B" (Illus. No. 47) on the intake valve and adjust the screw "A" so that the clearance when checked with a feeler gauge (after the lock nut has been tightened) will be a loose .006 or a tight .008 of an inch.

5. Crank the engine one complete revolution only, or until the mark UP-DC-1-6 is again under the pointer.

6. Continue to crank the engine slowly, feeling and revolving No. 1 intake push rod, until No. 1 intake valve just starts to open. The mark IN-OP-1-6 should now be under the pointer or nearly so.

Variations in adjusting the push rods as instructed in operation No. 4 and variations due to machining limits, may prevent the mark from coming exactly under the pointer. Therefore, do

not consider the timing gears improperly meshed if the mark IN-OP-1-6 is slightly away from the pointer when the valve starts to open.

If the timing gears were improperly meshed the mark IN-OP-1-6 would be at least 2¼" away from the pointer when No. 1 intake valve starts to open.

Tools Required—No. 25 and 33 open end wrenches, pliers, valve tappet adjusting wrenches C. O. 250, 251, 252 thickness gauge.

ARTICLE No. 26

To Remove and Replace Generator Drive Shaft

1. Remove the generator. (See Operation Article No. 17).
2. Drive the lower half of the generator coupling off of the drive shaft and remove the key.
3. Remove the front dust pan under the timing gear case.
4. Remove the oil pan. (See Operation Article No. 27).
5. Unscrew the three front gear case cover to front main bearing screws. By lining these screws with the holes in the starter clutch sprocket they can be removed.
6. Remove the six bolts holding the front main bearing and remove the bearing.
7. Remove the nuts on the two front engine bolts and loosen the nuts on the two rear engine bolts.
8. Raise the front end of the engine, with a jack or chain hoist, just enough to allow the generator drive shaft to be removed.
9. Reverse operations to assemble.

To adjust the drive shaft end play, screw the drive shaft adjusting screw (Illus. No. 29). up enough to just remove the end play in the shaft, and then give it one complete turn more to obtain the proper tension. Then tighten the lock nut. The adjusting screw has a left hand thread.

Replace the generator making sure the rubber bumpers are not cramped and that the generator base sets flat on the bracket before tightening the fastening screws.

Tools Required—Screw driver, pliers, hammer, No. 23, 25 and 29 open end wrenches, ½ inch socket wrench, 19/32 inch socket wrench, punch and pail.

ARTICLE No. 27

To Remove and Replace Oil Pan

1. Turn the drain valve handle on the right-hand side of the crankcase clockwise and drain the oil from the pan.
2. Pull up the drain valve handle and remove it from the hole in the crankcase.
3. The car should be raised and supported by horses as in Illus. No. 33.
4. Take out the cap screws holding the oil pan to the crankcase and remove the oil pan.

In removing the oil pan, drop it down as evenly as possible so as not to bend or otherwise damage the oil suction pipe.

5. Reverse operations to replace.

If the packing in the front and rear main bearing grooves are felt, the later type cork packings and oil pan gaskets should be installed. See the following information for this:

The groove in the bearing caps should be chamfered slightly to facilitate assembly of the packing. This can be done with a file.

The small end of the oil pan gasket is to be assembled on top of the packing. This is contrary to former practice with the felt packing, and it will necessitate tying the gasket to the bottom face of the crankcase with string at several screw holes making sure that the lips at the end of the gaskets fit properly in the grooves in the bearing caps. The oil pan packing may then be put in place. This must be handled carefully as it is a tight fit in the groove. A light coat of grease will help it to slip into place.

File a 1/8 inch radius on the corners of the semi-circular cuts at the end of the oil pan. *This is essential, as otherwise the pan will not lie flat to the crankcase causing a decided leak.*

Before replacing the pan always remove the screen and clean it and the pan thoroughly.

On the type of pan where it is necessary to enter the suction pipe in the hole in the screen, bolt the pan to the engine crankcase with the screen removed. Slide the spring, washer and felt on the suction pipe in the order named. A very small amount of cup grease placed on the suction pipe will hold them from dropping down while the screen is being replaced.

Tools Required—No. 25 open end wrench, ½ or 9/16 inch socket wrench, pliers, file, chain hoist, horses, pail.

ARTICLE No. 28

To Remove and Replace Oil Pan Drain Valve

1. Turn the drain valve handle in the right-hand side of the crankcase clockwise and drain the oil from the pan.
2. Pull up the drain valve handle and remove it from the hole in the crankcase.
3. Turn out the screws holding screen "B" and base "A" (Illus. No. 42).
4. Take out the two screws and remove oil indicator and bracket "B".
5. Remove spring "G" and retainer "E".
6. Loosen the set screw in the side of the strainer base "A". This will permit removal of valve "F".
7. Reverse operations to assemble.

Clean the screen thoroughly before replacing.

Fill the oil pan to the "full" position shown on the oil level indicator with medium oil in summer or light, *cold test* oil in winter.

Tools Required—No. 25 open end wrench, ½ inch socket wrench, pail.

ARTICLE No. 29

To Install Oil Filter on Cars Not So Equipped

1. Run the engine at a speed approximating 25 miles per hour and make a note of the oil pressure shown by the gauge on the instrument board.
2. Remove the oil pan, (See Operation Article No. 27). This is necessary to avoid getting chips in the pan during operation 3.
3. Spot the hole "A" (Illus. No. 20). on the right-hand side of the crankcase according to the dimensions given and drill through with a 21/64" drill. It will be necessary to drill on a slight downward angle in order to clear the hood sill.
4. Thread the hole with a 1/8" pipe tap.
5. The oil pan may now be replaced, after chips and burrs from tapping have been removed from the hole.
6. Disconnect the lower end of the present oil pressure gauge pipe "F".
7. Replace the present oil pump pressure pipe with the new pipe "E", (Illus. No. 20) and attach the fittings shown at "B".
8. Screw in the elbow at "A" and connect the lower end of pipes "C" and "D".
9. Temporarily attach the upper ends of pipes "C" and "D" to the oil filter using the two elbows as shown in Illus. No. 20. Hold the filter body against the dash and spot the four holes for the fastening bolts.

The correct location for the filter body is on the upper right side of the dash, with the lower left-hand corner of the filter just above the relay.

10. Remove the filter body and drill through at the points just spotted, with a 9/32 of an inch drill.
11. Fasten the filter body to the dash, putting the flat washers on the inside of the dash.
12. Connect pipes "C" and "D" to the filter.
13. Connect the lower end of pressure gauge pipe "F" as illustrated.
14. Start the engine and run it at a speed equivalent to 25 miles per hour.

ARTICLE No. 27-1

To Remove and Replace Oil Pan

The following revision in Article No. 27 applies to President and Commander Models having the drain plug in the oil pan.

1. Turn out the drain plug in the right-hand side of the oil pan, using the jack handle or a square ended tool, and drain the oil from the pan.
2. Remove oil level indicator.
3. The car should be raised and supported by horses as shown in Illus. No. 33.
4. Turn out the cap screws holding the oil pan to the crankcase and remove the oil pan.
5. Reverse operations to replace.

To remove the strainer base assembly, turn out the screws holding the strainer base brackets to the rear and rear center main bearing caps.

Whenever the oil pan and strainer base have been removed they should be thoroughly cleaned before replacing.

Tools Required—1/2 and 9/16 inch socket wrenches, pliers, screw driver, jack handle and pail.

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PRINTED IN U. S. A.

If the oil gauge after engine is warm, registers a pressure lower than that obtained before installing the filter, the tension of the relief valve spring must be increased. It is very important to bring the oil pressure back to the exact pressure obtained before installation and the car must not be operated until this is done.

Remove the relief valve plug and spring and install enough shims, part No. 111299, between the spring and the plug to bring the pressure to the correct figure.

Tools Required—No. 25 open end wrench, 1/2 or 9/16 inch socket wrench, pliers, pail, screw driver, hand drill, 21/64 and 9/32 inch drill, 1/8 inch pipe tap, No. 23 and 27 open end wrenches, hammer, center punch.

ARTICLE No. 30

To Remove and Replace Oil Distributor Pipe

1. Remove the front gear case cover. (See Operation Article No. 19).
2. Remove the oil pan. (See Operation Article No. 27).
3. Remove the glands holding the pipe in the crankcase webs. These can be turned out with a pair of long handled pliers.
4. Remove the distributor pipe through the front end of crankcase.
5. Reverse operations to replace.

Use new glands, driving them into place with C. O. 401 (See Vol. 8) and a hammer. They must be tightly sealed.

Test for leaks as described under C. O. 415, Vol. 8.

Tools Required—No. 25 and 27 open end wrenches, ½ inch socket wrench, pail, screw driver, adjustable wrench, Universal Puller C. O. 71, pliers, punch, hammer, gland installing fixture C. O. 401.

ARTICLE No. 31

To Remove and Replace Connecting Rod and Piston Assembly

1. Remove the oil pan. (See Operation Article No. 27).
2. Unscrew the oil suction pipe gland nut, remove the screw holding the pipe support to the crankcase web and remove the suction pipe.
3. Turn the crankshaft so that the connecting rod to be removed is at the bottom of its stroke.
4. Notice on which side of the rod are stamped the cylinder numbers so that it can be replaced in the same position. If the rod is not numbered, mark it so that it can be properly assembled. The rods are ordinarily stamped on the cam shaft side.
5. Remove the cotter pins and nuts from the connecting rod cap bolts.
6. Remove the connecting rod cap. There are no shims in the connecting rod bearings.
7. Push the rod up just far enough for the bolts to clear the crank pin and swing it to the right hand side of the engine. Then replace the cap and turn the nuts finger tight.
8. Pull the connecting rod and piston down, at the same time turning the crankshaft so that the piston clears the cheek of the crankshaft. (See Illus. No. 34).
9. Reverse operations to replace.

Before replacing, align the rod (Illus. No. 50. 51 and 52). See instructions under C. O. 68, Vol. 8.

Tools Required—No. 25 open end wrench, ½ inch socket wrench, ¾ inch socket wrench, pliers, hammer, pail, rod aligning fixture C. O. 68.

ARTICLE No. 32

To Install New Connecting Rod

1. Remove the connecting rod and piston assembly. (See Operation Article No. 31).
2. Remove the piston pin clamp screw from the upper end of the rod.

3. Place the piston in a piston vise and with a hammer and brass drift, drive out the piston pin. Care must be taken not to knock the piston out of round.

4. Ream the new bearing by following instructions on Connecting Rod Reamer in Vol. 8.

5. Following the reaming operation the sides of the connecting rod bearing must be dressed down, if necessary, to give at least .004 of an inch end play when assembled on the crankshaft.

6. To make sure that the bearing has the proper oil clearance, test with a piece of paper about one inch square which has been checked with a micrometer and found to be .0015" thick. Place the paper between the cap and the shaft at the center of the bearing and tighten the cap. The shaft should then offer slight resistance to turning.

7. Test the connecting rod for alignment as described under C. O. 68, Vol. 8.

8. Reverse operations 1, 2 and 3 to assemble.

Tools Required—No. 25 and 27 open end wrenches, 1/2, 9/16 and 3/4 inch socket wrenches, pliers, hammer, 7/8 inch brass drift, connecting rod aligning fixture C. O. 68, connecting rod reamer, pail.

ARTICLE No. 33

To Install New Piston Bushings

1. Disassemble the piston and connecting rod. (See Operation Article No. 32, operations 1, 2 and 3).

2. Insert the piston bushing installing fixture (C. O. 128-1, Vol. 8) between the piston bosses as shown at "A" (Illus. No. 28) and expand it until tight.

3. With the special drift "B" (C. O. 128-2, Vol. 8) press both bushings out at once, using an arbor press.

The piston bushing installing fixture C. O. 128-1 prevents piston distortion in this operation.

4. Press the new bushings in from each side of the piston and remove the fixture. In putting in new bushings, it is important that the oil hole in the bushing registers with the oil hole in the piston boss.

5. With expansion reamer C. O. 91, ream the bushings to size. The proper fit is obtained when the rod will not swing freely but will just carry down its own weight.

6. Check the piston pin bore in the piston for alignment as described under C. O. 50, Vol. 8.

7. Check the connecting rod for alignment as described under C. O. 68, Vol. 8.

8. Reverse operations to assemble.

Tools Required—No. 27 open end wrench, pliers, hammer, connecting rod aligning fixture, C. O. 50, piston vise C. O. 113, 7/8 inch brass drift, piston bushing installing fixture C. O. 128, C. O. 91 expansion reamer.

ARTICLE No. 34

To Tighten Connecting Rod Bearings

1. Remove the oil pan. (See Operation Article No. 27).

The car should be raised and supported by horses as shown in Illus. No. 33.

2. Turn the crankshaft so that the connecting rod to be worked on is at the bottom of its stroke.

3. Remove the cotter pins and nuts from the connecting rod cap bolts.

4. Remove the connecting rod cap. There are no shims in the connecting rod bearings.

5. Lay a piece of medium emery cloth on a surface plate or piece of plate glass and rub the cap over the emery cloth with an even pressure. Be careful not to remove very much metal at one time.

Wash the cap in gasoline to remove all dust and dry it thoroughly.

Also see that the upper half of the bearing and crank pin are free from oil.

6. To check the clearance use a piece of paper

about one inch square which has been checked by a micrometer and found to be .0015 of an inch thick. Place the paper between the cap and the shaft at the center of the bearing and then tighten cap. The shaft should then offer slight resistance to turning. Turn the shaft in one direction only, for about four revolutions and remove the cap. A slight imprint of the paper should be in the center of the bearing. If the imprint does not show all of the paper making contact with the bearing it indicates the bearing is improperly fitted. If the paper shows full imprint on the bearing and the shaft turns with only slight resistance it shows cap to be properly fitted and adjusted.

If the shaft turns hard with the paper placed between the shaft and bearing there is not enough clearance. Check frequently with paper to avoid removing too much metal.

7. Oil the cap liberally, then replace it, draw the nuts up tight and put in cotter pins. After tightening the nuts, strike the lower end of bolts a sharp blow with a hammer and brass drift to permit the cap to align itself.

8. Repeat operations 2 to 7 with the other rods in turn.

9. Reverse operations to reassemble.

Tools Required—No. 25 open end wrench, ½ and ¾ inch socket wrenches, pliers, hammer, ⅞ inch brass drift, pail.

ARTICLE No. 35

To Tighten Main Bearings

1. Remove the oil pan. (See Operating Article No. 27).

The car should be raised and supported by horses as shown in Illus. No. 33.

2. Remove the front dust pan.

3. Remove the wire locking the cap screws holding each main bearing cap.

4. Tighten the bearings in rotation, removing the rear bearing cap first.

Clean all loose metal from the oil grooves, oil holes and edges of the bearing and wipe clean. Also rotate the crankshaft and wipe all oil from the journal.

5. Lay a piece of medium emery cloth on a surface plate or piece of plate glass. Dress the cap down by rubbing it over the emery cloth with an even pressure. Be careful not to remove very much metal at one time. Wash the cap in gasoline to remove all dust and dry thoroughly.

6. To check the clearance use a piece of paper about one inch square which has been checked by micrometer and found to be .0015 of an inch thick. Place the paper between the cap and the shaft at the center of the bearing and tighten the cap. The shaft should then offer slight resistance to turning. Turn the shaft in one direction only, for about four revolutions and remove the cap. A slight imprint of the paper should be in the center of the bearing. If the imprint does not show all of the paper making contact with the bearing, it indicates the bearing is improperly fitted. If the paper shows full imprint on the bearing and the shaft turns with only slight resistance, it shows the cap to be properly fitted and adjusted.

If the shaft turns hard with the paper placed between the shaft and the bearing there is not enough clearance. Check frequently with paper to avoid removing too much metal.

7. After the bearing has been properly adjusted, proceed as outlined above with the next bearing.

8. After all bearings have been fitted, tighten all bearing cap screws and put in new lock wires. You should now be able to turn the crankshaft very easily by means of the starting crank.

9. Reverse operations to assemble.

Tools Required—No. 25 open end wrench, pail, screw driver, pliers, 1/2, 9/16, 7/8 inch socket wrenches, chain hoist and horses.

ARTICLE No. 36

To Remove and Replace Cylinder Block

1. Remove the connecting rod and piston assemblies (See Operation Article No. 31).

2. Remove the hood.

3. Remove the radiator brace rods.

4. Open the drain cock under the water pump and drain the water from the cooling system.

5. Turn off the two cylinder head stud nuts or cap screws holding the horn bracket to the engine and remove the horn and bracket assembly.

6. Remove the intake manifold, vacuum tank and carburetor assembly. (See Operation Article No. 1).

7. Remove the exhaust manfold (See Operation Article No. 2).

8. Remove the two nuts holding the ignition cable tube brackets ot the water header. Remove the cables, tube and distributor cover from the engine.

9. If the fan is fastened to the stud in the cylinder block it will be necessary to remove it. (See Operation Article No. 10, operations 1 to 6).

10. Turn out the cap screw holdng the generator bracket to the cylinder block.

11. Loosen the upper water pump to cylinder block hose clamp.

12. This operation applies only to right-hand control cars.

A. Pull the cotter pins and remove the contral rods from the control cross shaft levers on the right side of engine.

B. Loosen the clamp screws in the two levers on the control cross shaft on the left side and pull off the levers.

C. Loosen the set screw in the inner collar on the cross shaft on the right side and pull out the cross shaft.

13. Remove the valve cover plate and turn off the six nuts on the left side holding the cylinder block to the crankcase.

14. Remove the push rod guide clamps "B" and spacers "C" (Illus. No. 48).

15. On right-hand control cars only, remove the cross shaft bearing.

16. Remove the junction block housing cover and remove the two screws holding the block to the bracket.

17. Turn off the seven nuts on the right side of the engine holding the cylinder block to the crankcase. Also on right-hand control cars remove the other cross shaft bearing.

18. Disconnect the two wires at the relay if it is located on the dash.

19. Disconnect the radiator upper hose at the water header.

20. The cylinder block is now free to be lifted from the crankcase.

Chain hoist and engine lifting rings as shown in Illus. No. 26 (lifting engine from car), can also be used for lifting the block from the crankcase.

21. Reverse operations to assemble. Make sure that all gaskets are in good condition and in place.

Tools Required—No. 25 and 29 open end wrenches, adjustable wrench, screw driver, pliers, hammer, chain hoist, motor lifting hooks C. O. 119 and C. O. 120.

ARTICLE No. 37

To Remove and Replace Engine and Transmission Assembly

1. Turn the drain valve handle on the right-hand side of the crankcase clockwise and drain the oil from the pan.

2. Remove the hood.

3. Remove the radiator assembly. (See Operation Article No. 8).

4. Unscrew and remove the water pump drain pipe.

5. Disconnect the radiator brace rods at the dash and remove the rods.

6. Disconnect the gasoline pipe at the top of the vacuum tank.

7. Disconnect the windshield wiper pipe at the intake manifold connection.

8. Disconnect the hand throttle connection at "F" (Illus. No. 6) and the foot accelerator connection at "E".

9. Loosen the two screws "X" and "W" (Illus. No. 6) holding the choke tube and wire at the carburetor.

10. Remove the two bolts "T" (Illus. No. 6) holding the exhaust manifold to the exhaust pipe flange.

If the car is equipped with an air cleaner as in Illus. No. 6, disconnect the exhaust manifold at "U". It is not necessary to remove the air cleaner assembly from the engine.

11. Turn off the two cylinder head stud nuts

ARTICLE No. 35-1

To Tighten Main Bearings

The following revision in Article No. 35 applies to Big Six engines starting with engine No. EW-12029 and ES-59250.

The main bearings on these engines are not designed to be tightened or adjusted and no stock should be removed from the bearing caps under any condition.

When a knock develops from wear or lack of lubrication a new set of main bearings should be installed as instructed in Operation Article No. 39-2.

ARTICLE No. 37-1

To Remove and Replace Engine and Transmission Assembly

The following revision in Article No. 37 applies to Big Six cars built with the Long Clutch and having the manual spark and heat controls on the instrument board.

1. Turn the drain valve handle on the right hand side of the crankcase clockwise, or remove the drain plug in the right hand side of the oil pan and drain the oil from the pan.
2. Remove the hood.
3. Unscrew and remove the water pump drain pipe.
4. Remove the radiator assembly. (See Operation Article No. 8).
5. Disconnect the radiator brace rods at the dash and remove the rods.
6. Disconnect the gasoline pipe at the top of the vacuum tank.
7. Disconnect the windshield wiper pipe at the top of the vacuum tank.
8. Disconnect the hand throttle connection at "F" (Illus. No. 6) and the foot throttle connection at "E".
9. Disconnect the choke tube and wire at the carburetor.
10. Remove the two bolts "T" (Illus. No. 6) holding the exhaust manifold to the exhaust pipe flange.
11. Turn off the two cyclinder head cap screws holding the horn bracket to the engine. Disconnect the horn cables and remove the horn and bracket assembly.
12. Disconnect the oil pressure gauge pipe and oil filter pipe at the pump connection at the rear of the cyclinder block.
13. Disconnect the cables from the starter motor.
14. *On right hand control cars,* disconnect the foot accelerator and hand throttle rods on the right hand side of the engine.
15. Disconnect the ignition coil cable at the coil.
16. Disconnect the generator cable at the generator.
17. Unlock and remove the large floor board.
18. Take out the two screws holding the small floor board and remove the board.
19. Loosen the accelerator plunger lock nut under the toe board and unscrew the plunger from the rod.
20. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.
21. Turn out the large screw at each side of the toe board and lift out the toe board.
22. Disconnect the battery ground connection and also the three cables attached to the starter switch.
23. Remove the starter switch.
24. Remove the clutch shifter arm spring "E" (Illus. No. 89) and by removing the cotter pin, washer and coil spring the clutch pedal "D" can be slipped off the end of the shaft.
25. Remove the clevis pin "A" (Illus. No. 89) and then the brake pedal "C" can be removed.
26. Disconnect the speedometer cable at the transmission.
27. Remove the six bolts and lift off the gear shift base assembly.
28. Unscrew the sleeve packing nut at the front end of the propeller shaft. If removing engine from bus chassis it will be necessary to remove the six bolts in the front universal.
29. Remove the clevis pin connecting the parking brake cable to the brake bell crank.

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PRINTED IN U. S. A.

30. Disconnect and remove the manifold heat control and spark advance control, tubes and wires at the dash levers.

31. Disconnect the radimeter plug at the cylinder head.

32. Remove the four bolts holding the engine to the frame.

33. Place a cloth over the transmission to prevent dirt from falling into it while the engine is being lifted out.

34. Screw the engine lifting rings C. O. 120, (See Special Tool Catalog) into No. 1 and No. 6 spark plug holes as shown in Illus. No. 26.

35. The chain hoist hooks C. O 119 can now be hooked into the rings and the engine lifted from the car.

36. Reverse operations to assemble.

Tools Required—No. 23, 27, 29 and 33 open end wrenches, pliers, screw driver, adjustable wrench, 1/2 and 9/16 in. socket wrenches, engine lifting rings and hooks C. O. 119 and 120, chain hoist, hammer and pail.

or cap screws holding the horn bracket to the engine. Disconnect the horn cables and remove the horn and bracket assembly.

12. Disconnect the oil pressure gauge pipe at the pump. If the car is equipped with an oil filter, disconnect the two filter pipes at both ends and remove the pipes.

13. Disconnect the cables from the starter motor.

14. *On right-hand control cars,* disconnect the foot accelerator and hand throttle rods on the right hand side of the engine.

15. Disconnect the ignition coil to junction block cable at the coil.

16. Disconnect the generator cable at the generator.

17. Turn off the two cylinder stud nuts holding the two conduit brackets to the engine and remove the brackets.

18. Turn off the two cylinder stud nuts holding the junction block bracket and remove the junction block assembly.

19. Disconnect the wires at the relay.

20. Remove the machine screws holding the two side pans to the crankcase.

21. Unlock and remove the large floor board.

22. Take out the two wood screws holding the small floor board and remove the board.

23. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger locking nut under the toe board and unscrew the plunger from the accelerator rod.

24. Take out the screws holding the toe plate in the upper left-hand corner of the toe board and remove the plate.

25. Remove the two large screws at each side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.

26. Disconnect the two cables at the starter switch and also the battery ground cable.

27. Take out the two bolts holding the starter switch to the bracket and remove the switch.

28. Remove the clutch pedal by taking out the two bolts holding the pedal to the pedal arm.

29. Remove the adjusting nut at the brake pedal pad and remove the pedal pad.

30. Remove the clevis pin at "E" (Illus. No. 7) on each side of the transmission, on hydraulic brake equipment only.

31. Disconnect the speedometer cable at "I" (Illus. No. 7).

32. Remove the six bolts "G" and lift off the gear shift base assembly.

33. Unscrew the brass sleeve at the front end of the propeller shaft. If removing engine from bus chassis it will be necessary to remove the six bolts at the front universal.

34. Remove the clevis pin "H" (Illus. No. 7) connecting the parking brake cable to the brake bell crank.

35. Unscrew the service brake pump pressure gauge pipe at "J" (Illus. No. 7) on hydraulic brake equipment.

36. Place a cloth over the transmission to prevent dirt from falling into it while the engine is being lifted out. It is advisable to drain the oil from the hydraulic brake transmission.

37. Remove the four bolts holding the engine to the frame.

38. Screw the engine lifting rings C. O. 120, (See Special Tool Catalog) into No. 1 and No. 6 spark plug holes as shown in Illus. No. 26.

39. The chain hoist hooks (C. O. 119) can now be hooked into the rings and the engine lifted from the car (Illus. No. 26).

40. Reverse operations to assemble.

Tools Required—No. 23, 27, 29 and 33 open end wrenches, pliers, screw driver, adjustable wrench, 1/2 and 9/16 inch socket wrenches, engine lifting rings and hooks C. O. 119 and 120, chain hoist, hammer, pail.

ARTICLE No. 38

To Remove and Replace Crankshaft

1. Remove the engine from the car. (See Operation Article No. 37).

2. Take out the bolts "M" (Illus. No. 7) and remove the transmission, being careful to lift it

straight back so as not to spring the pinion shaft.

3. Place the engine in an engine stand and turn it upside down.

4. Remove the oil pan. (See Operation Article No. 27).

5. Remove the clutch assembly from the flywheel. (See Operation Article No. 17, Vol. 6, or use the following operations).

A. Remove the nine fastening screws "N" (Illus. No. 8) holding the outer plate "A" to the flywheel. Turn these screws out gradually so as to equalize the strain on the outer plate.

B. Outer plate "A", (Illus. No. 8) driving flange "B", inner plate "C" with springs can now be removed in the order named.

6. Remove the small dust pan on the lower front side of the flywheel housing.

7. Remove the six nuts holding the flywheel to the crankshaft flange.

8. The flywheel can now be removed.

9. Remove the gear case front cover. (See Operation Article No. 19).

10. Take out the six piston and connecting rod assemblies. (See Operation Article No. 31, operations 2 to 9).

11. Remove the wire locking the cap screws holding each main bearing cap and remove the screws.

12. Remove the four bearing caps. Before lifting off the two center caps, see that the caps and case are marked, so that in reassembling they will be placed in the original position.

13. The crankshaft can now be lifted out of the case.

14. Reverse operations to assemble.

If necessary to tighten the bearings follow Operation Article No. 35.

Use plenty of oil on bearings when reassembling.

When replacing flywheel see that mark "O" on flywheel lines up with mark "O" on crankshaft flange at "D" (Illus. No. 60).

Tools Required—No. 21, 25, 29 and 33 open end wrenches, screw drivers, pliers, 9/16, 1/2, 11/16, 5/8 and 7/8 inch socket wrenches, hammer, punch, engine lifting hooks C. O. 119 and 120, chain hoist, engine stand, clutch flange aligning arbor C. O. 402, Universal Puller C. O. 71, adjustable wrench, pail.

ARTICLE No. 39

To Install New Main Bearings

1. Remove the crankshaft. (See Operation Article No. 38).

Leave the cylinder block bolted tight to the crankcase while installing the bearings.

2. Remove all the bearings shells from the crankcase and caps.

3. Thoroughly clean the bore of the caps and the bearing receiving holes in the crankcase and insert the bronze backed bearings. Hammer them in solidly, using a flat hardwood block not less than 3 x 4 inches in size, holding it flat against the two straight edges of the bearing.

4. Screw in the bearing anchoring screws making sure to tighten them securely. With a chisel or screw driver stake the babbit into the screw slot so that the screws will not loosen.

5. File the edges of the cap bearings flush with the cap. File the edges of the bearings in the case not quite flush with the case, letting them project about .002 or .003 of an inch above the case, as nearly as can be determined. This is done in order that when the cap is assembled the edges of the bearings will come together with a little harder contact than the cap and case, thereby tending to hold the bearings more securely.

6. Fit the thrust bearings (rear center) to the crankshaft before anchoring them into the case and cap.

The proper end play clearance which is .004 to .006 of an inch can be obtained by dressing off the sides of the bearings using a sheet of emery cloth and surface a plate.

7. Test the crankshaft using indicator C. O. 63 with surface plate C. O. 135 and V-blocks C. O. 136. (See C. O. 63, Vol. 8).

If the crankshaft is straight within .004 of an inch it can be used.

8. Test the crankshaft journals with a micrometer. An out of round crankshaft should be replaced with a new shaft.

ARTICLE No. 39-1

To Install New Main Bearings

The following revision in Article No. 39 applies to Big Six Custom car engines starting with No. ES 46732, and engine No. ES 42908 for cars previous to the Custom models equipped with dowel pins instead of screws in the main bearings.

1. Remove the crankshaft (See Operation Article No. 38).

2. Remove all the bearing shells from the crankcase and caps. Thoroughly clean the bore of the caps and the bearing receiving holes in the crankcase.

3. Fit the thrust bearing (rear center) to the crankshaft for proper end clearance, which should be .004 to .006 of an inch. This can be done by dressing down the sides of the bearing, using a sheet of emery cloth on a surface plate.

4. Place the bearing dowel pins in the holes provided for them at the center of the bearing position in the case and cap. Now hammer the bearing shells in the case, being sure the oil holes line up in the bearing and case, using a hard wood or iron block not less than 3 x 4 inches in size. Drive down as nearly flush with the crankcase and cap as possible, holding the block flat against the two straight edges of the bearing, care being taken to line up the dowel pin in the bearing hole as the bearing enters.

The dowel pin hole in the bearing shell lower or cap half is oval to allow for alignment of the bearing in the cap. The bearing shells come so uniform that it is advisable not to file them, but to leave the edges project above the crankcase or cap surface .002 or .003 of an inch.

In case the cap has previously been cut down, it may be necessary to dress down the bearing to within .002 or .003 of an inch of the cap surface. This projection is allowed so that when the bearing caps are tightened down the pressure will be slightly greater at contact along the bearing edge than between the cap and the case, tending to hold the bearing rigidly in place.

5. Test the crankshaft using indicator C. O. 63 and surface plate C. O. 135 and V block C. O. 136 (see Vol. 8).

If the crankshaft is straight within .004 of an inch it can be used.

6. Test the crankshaft journals with a micrometer. An out of round crankshaft should be replaced with a new shaft.

7. Bolt the four bearing caps into place. The bolt holes in the caps are drilled slightly oversize. This is done so that the cap can be shifted and properly aligned with the bearing in the case.

This procedure is very important and the edges of the bearing should be exactly flush before tightening the bolts.

Note—Line reaming should always be used as the need for proper clearance and a perfect bearing is much greater with the pressure lubrication system. (See instructions and illustrations for the Taft-Pierce Service Reamer in Vol. 8.)

8. Following the reaming operation, remove the reamer and the bearing caps, and lay the crankshaft in place.

9. Check each bearing for clearance, one at a time, with a piece of paper about 1 inch square which has been checked with a micrometer for .0015 of an inch thickness.

Place the paper between the cap and the crankshaft at the center of the bearing and tighten the cap. The shaft should then offer slight resistance to being turned.

10. After all bearings have been checked, tighten all the bearing cap screws and put in new lock wires. The crankshaft should now turn freely by use of the starting crank.

11. Reverse operations in Operation Articles No. 38 to reassemble.

Tools Required—No. 21, 25, 29 and 33 open end wrenches, screw driver, pliers, 1/2, 9/16, 5/8 and 7/8 inch socket wrenches, hammer, punch, engine lifting hooks C. O. 119 and 120, chain hoist, engine stand, Clutch Flange Aligning Arbor C. O. 402, Universal Puller C. O. 71, adjustable wrench, pail, micrometers indicator C. O. 63, surface plate C. O. 135, V-blocks C. O. 136, hardwood block, kerosene, Taft-Pierce Service Reamer, inside calipers.

Insert in Volume Three, after page 128.

ARTICLE No. 39-2

To Install New Main Bearings

The following revision in Operation Articles No. 39 and No. 39-1 applies to Big Six engines starting with engine No. EW-12029 and ES-59250, equipped with the "interchangeable" type bearings.

1. Remove the crankshaft from the engine. (See Operation Article No. 38).

2. Pry the old bearing shells out of the crankcase and bearing caps.

3. Check the crankshaft for alignment and out of round, see Illus. No. 10, Vol. 8. Also test the shaft for wear with a micrometer. If the crankshaft is out of alignment more than .002 of an inch, it must be straightened. If it is worn or out of round more than .002 of an inch, it must be ground down sufficiently to true up the shaft and be exactly, either; .005, .010 or .015 of an inch undersize from the original standard size. See General Information, "Main Bearings" 5-B-1.

4. Fit the thrust bearing (rear center) to the crankshaft for proper end clearance (.004 to .006 of an inch) by dressing down the sides of the bearing, using a sheet of emery cloth on a surface plate.

5. Install the set of bearing shells which match the size of the crankshaft. Use a hardwood block to drive the shells in flush with the face of the crankcase and caps.

6. Thoroughly clean the crankcase and caps before installing the bearing shells. Also clean the oil passageways in the crankcase and crankshaft and see that the oil holes in the shells match the ones in the crankcase.

7. Replace the crankshaft and check the bearings for clearance as described in Article No. 39.

8. Replace the connecting rod assemblies and then test the oiling system with the Oil Test Cylinder C. O. 415 (See Vol. 8).

9. Reverse operations to assemble.

Tools required—No. 21, 25, 29 and 33 open end wrenches, screw driver, pliers, 1/2, 9/16, 11/16, 5/8 and 7/8 inch socket wrenches, hammer, punch, engine lifting hooks, C. O. 119 and 120, chain hoist engine stand, clutch flange aligning arbor C. O. 402, universal puller C. O. 71, adjustable wrench, pail, micrometer, indicator C. O. 63, surface plate C. O. 135, V-block C. O. 136, hardwood block and oil test cylinder C. O. 415.

9. Bolt the four bearing caps into place. The bolt holes in the bearing caps are drilled slightly oversize. This is done so that the cap can be shifted and properly aligned with the bearing in the case. This procedure is very important and the edges of the bearings should be exactly flush before tightening the bolts.

NOTE:—Line reaming should always be used in preference to hand scraping to seat the bearings. The need for proper clearance and a perfect bearing is much greater with pressure lubrication than with the previous splash system. (See the instructions and illustrations for the Taft-Pierce Service reamer in Vol. 8).

10. Following the reaming operation, remove the reamer and bearing caps and lay the crankshaft in place.

11. Check each bearing, one at a time, for proper clearance, with a piece of paper about one inch square which has been checked by micrometer and found to be .0015 of an inch thick.

Place the paper between the cap and the shaft at the center of the bearing and tighten the cap. The shaft should then offer slight resistance to being turned.

12. After all bearings have been checked, tighten all bearing cap screws and put in new lock wires. You should now be able to turn the crankshaft very easily by means of the starting crank.

13. Reverse operations in Operation Article No. 38 to reassemble.

Tools Required—No. 21, 25, 29 and 33 open end wrenches, screw driver, pliers, 9/16, 1/2, 11/16, 5/8, and 7/8 inch socket wrenches, hammer, punch, engine lifting hooks C. O. 119 and 120, chain hoist, engine stand, clutch flange aligning arbor C. O. 402, Universal Puller C. O. 71, adjustable wrench, pail, micrometers, indicator C. O. 63, surface plate C. O. 135, V-blocks, C. O. 136, hardwood block, lard oil, Taft-Pierce Service Reamer, inside calipers.

ARTICLE No. 40

To Install New Thrust Bearing Lower Half

This operation should be performed only in an emergency and the customer should be directed to have a complete bearing, upper and lower halves, installed by line reaming at the first opportunity.

1. Remove the oil pan. (See Operation Article No. 27).

2. Remove the locking wire holding the thrust bearing cap bolts.

3. Remove the bolts and the thrust bearing cap.

4. Remove the anchoring screws and knock the bearing shell out of the cap.

5. See that the cap and the new bearing are clean.

6. Drive the new bearing into the cap with a hardwood block and hammer.

7. Screw in the anchoring screws securely and with a chisel or screw driver stake the babbitt into the screw slot. This will prevent the screw from loosening.

8. File the edge of the bearing shell, if necessary, to bring it flush with the face of the cap.

9. Fit the bearing side flanges to the crankshaft, dressing them down with emery cloth on a surface plate or plate glass until .004" end play is obtained.

10. Coat the shaft lightly with Prussian Blue.

11. Bolt the cap into place tightening the bolts evenly until a slight resistance is felt when rotating the crankshaft with the crank.

12. Remove the cap and scrape the high spots.

13. Repeat operations 11 and 12, removing enough babbitt from the bearing to give the necessary .002 of an inch clearance and at least a 75% bearing surface.

14. To check the clearance use a piece of paper about one inch square which has been checked by micrometer and found to be .0015 of an inch thick. Place the paper between the cap and shaft at the center of the bearing and tighten the cap. The shaft should then offer slight resistance to turning. Turn the shaft in one direction only, for about four revolutions and remove the cap. A slight imprint of the paper should be in the center of the bearing. If the imprint does not show all of the paper making contact with the bearing, it indicates the bearing is improperly fitted. If the paper shows full imprint on the bearing and the shaft

turns with only slight resistance, it shows the cap to be properly fitted and adjusted. If the shaft turns hard with the paper placed between the shaft and the bearing there is not enough clearance. Check frequently with paper.

15. After the bearing is properly scraped and adjusted for clearance, remove the cap, clean the bearing and shaft and coat them with oil before replacing.

16. Reverse operations to assemble.

Tools Required—*No.* 25 open end wrench, ½ and ⅞ inch socket wrenches, screw driver, pliers, pail, bearing scraper, Prussian blue, oil can, emery cloth, surface plate C. O. 135, Hardwood block, hammer, chisel, micrometer.

ARTICLE No. 41

To Remove Flywheel

1. Remove the floor and toe boards. (See Operation Article No. 37, operations 21 to 25 inclusive).

2. Remove the transmission assembly. (See Operation Article No. 4, Vol. 6, or use the following operations:)

A. Loosen the clamp screw holding the clutch pedal adjusting level to the shifter shaft and drive off the clutch pedal arm and the adjusting lever.

B. Remove the key from shifter shaft.

C. Remove the brake rod clevis pin "D" (Illus. No. 7). Also clevis pin "C" on hydraulic brake equipment.

D. Remove the brake pedal arm from the clutch shifter shaft.

E. Remove clevis pin "E" from the brake operating lever on each side of the transmission on hydraulic brake equipment only.

F. Remove the six bolts at the rear universal joint. Unscrew the brass nut at the front end of the propeller shaft and remove the propeller shaft and real universal joint assembly.

G. Disconnect the parking brake cable at "H" (Illus. No. 7).

H. Disconnect the speedometer cable at "I" (Illus. No. 7).

I. Disconnect the brake pump pressure gauge pipe at "J" on hydraulic brake equipment only.

J. Remove the screws "M" holding the transmission to the flywheel housing. Take care in this operation to support the transmission so that the transmission pinion will not be sprung.

K. Transmission can now be removed, carefully pulling it straight out until the transmission pinion is disengaged from the clutch driving flange, then lifting it up to clear the frame cross member and lowering it to the floor.

3. Remove the clutch from the flywheel. (See Operation Article No. 17, Vol. 6, or use the following operations:)

A. Remove the nine fastening screws "N" (Illus. No. 8) holding the outer plate "A" to the flywheel. Turn these screws out gradually so as to equalize the strain on the outer plate.

B. Outer plate "A" (Illus. No. 8), driving flange "B", inner place "C",, with springs, can now be removed in the order named.

4. Remove the small dust pan on the lower front side of the flywheel housing.

5. Remove the six nuts holding the flywheel to the crankshaft flange. When removing the nuts, the bolts can be held from turning with a wrench through the opening from which the pan was removed.

6. The flywheel can now be removed.

7. Reverse operations to replace. When replacing the flywheel see that the mark "O" on the flywheel lines up with the mark "O" on the crankshaft flange at "D" (Illus. No. 60).

If these marks are not visible, turn the crankshaft so that pistons No. 1 and 6 are on upper dead center; then assemble the flywheel so that the mark "UP-DC-1-6" (Illus. No. 18) is opposite the timing pointer in the flywheel housing.

When putting the clutch driving flange into position it must be properly centered so that the

ARTICLE No. 41-1

To Remove Flywheel

The following revision in Article No. 41 applies to Big Six cars starting with serial No. 4,000,001 and 2,116,678 which were built with the "Long Clutch."

1. Remove the floor and toe boards. (See Operation Article No. 37-1, operations 17 to 21 inclusive.)

2. Remove the transmission assembly. (See Operation Article No. 4, Vol. 6, or use the following operations:)

A. Remove the cotter pin, washer and coil spring and slip the clutch pedal "D" off of the pedal shaft. (Illus. No. 89).

B. Remove the brake rod clevis pin "A" and slip the brake pedal "C" off of the end of the shaft.

C. Remove the six bolts in the rear universal joint and unscrew the packing nut at the front end of the propeller shaft. The propeller shaft can now be removed.

D. Disconnect the parking brake cable at "H". (Illus. No. F.)

E. Disconnect the speedometer cable at "I" (Illus. No. 7).

F. Remove the screws holding the transmission to the flywheel housing, taking care to support the transmission so that the transmission pinion will not be sprung.

G. The transmission can now be removed, carefully pulling it straight out until the transmission pinion is disengaged from the clutch driving flange, then lifting it up to clear the frame cross member and lowering it to the floor.

3. Remove the clutch from the flywheel. (See Operation Article No. 17-1, Vol. 6, or use the following:)

A. Remove the six fastening screws "H" (Illus. No. 90) holding the outer plate "A" to the flywheel. Turn these screws out gradually so as to equalize the strain on the outer plate.

B. Outer plate assembly "A" (Illus. No. 90) and driving flange "F" can now be removed.

4. Remove the small dust pan on the lower front side of the flywheel housing.

5. Remove the six nuts holding the flywheel to the crankshaft flange. When removing the nuts, the bolts can be held from turning with a wrench through the opening from which the pan was removed.

6. The flywheel can now be removed.

7. Reverse operations to replace. When replacing the flywheel see that the mark "O" on the flywheel lines up with the mark "O" on the crankshaft flange at "D" (Illus. No. 60).

If these marks are not visible, turn the crankshaft so that pistons No. 1 and 6 are on upper dead center; then assemble the flywheel so that the mark "UP-DC-1-6" (Illus. No. 18) is opposite the timing pointer in the flywheel housing.

When putting the clutch driving flange into position it must be properly centered so that the flutes in the flange hub will line up with the pilot bearing when replacing the transmission assembly. After replacing the flange, put C. O. 402, Clutch Driving Flange Aligning Arbor, through the flange hub so that the pilot on the arbor enters the pilot bearing in the crankshaft.

Then replace the outer plate, tightening the screws gradually and equally so as not to strain the plate.

Pull out the aligning arbor C. O. 402.

See Operation Article No. 20-1, Vol. 6, to adjust the clutch pedal. *Do not attempt to adjust the clutch fingers.*

Tools Required—No. 23, 27 and 29 open end wrenches, 1/2, 9/16 and 3/4 inch socket wrenches, pliers, screw driver, hammer, punch, jack and clutch flange aligning Arbor C. O. 402.

Issued October 15, 1927
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PRINTED IN U. S. A.

flutes in the flange hub will line up with the pilot bearing when replacing the transmission assembly. After replacing the flange, put C.O. 402, Clutch Driving Flange Aligning Arbor, through the flange hub so that the pilot on the arbor enters the pilot bearing in the crankshaft.

Then replace the outer plate, tightening the screws gradually and equally so as not to strain the plate. Be sure that the holes under the three adjusting screws are over the three pins in the inner plate.

Pull out the aligning arbor C.O. 402.

See Operation Article No. 20, Vol. 6, for adjusting the clutch.

Tools Required—No. 23, 27 and 29 open end wrenches, 1/2, 9/16 and 3/4 inch socket wrenches, pliers, screw driver, hammer, punch, jack, clutch flange aligning arbor C.O. 402.

ARTICLE No. 42

To Remove Oil Pump Assembly

1. Remove the flywheel. (See Operation Article No. 41).
2. Remove the nut holding the oil pressure gauge pipe to the pipe "F" (Illus. No. 60) on the pump.
3. Unscrew the short pressure pipe "F" and remove it from the pump.
4. Turn out the five cap screws holding the pump to the crank case and remove the pump.
5. Reverse operations to replace.

Make sure that the oil pump body gasket is in good condition and in place. It is advisable to use a new gasket. Shellac the gasket to the pump but do not apply shellac to the other side of the gasket.

Tools Required—No. 23, 27 and 29 open end wrenches, 1/2, 9/16 and 3/4 inch socket wrenches, pliers, screw driver, hammer, punch, jack, clutch flange aligning arbor C.O. 402.

ARTICLE No. 43

To Install New Flywheel Housing

1. Remove the flywheel. (See Operation Article No. 41).

The engine need not be removed from the car, but must be blocked up or suspended from a chain block before removing the flywheel housing.

2. Remove the locking wire and turn out the fastening screws "A" (Illus. No. 21) holding the flywheel housing to the engine crankcase.
3. Remove the bolts at "B" and remove the old flywheel housing.

NOTE—When replacing a flywheel housing it is essential that the face of the new housing to which the transmission is fastened, be concentric with the crankshaft. This assures perfect alignment of the tranmission with the engine.

The new housing will come with surplus stock at dimension "B" (Illus. No. 25) and on the outer face of dimension "A". The two bolt holes "C" will come with a certain amount of reaming stock.

It is impossible to install a new flywheel housing properly without the use of Flywheel Housing Refacing and Boring Fixture C.O. 425.

There should be as little excess play in the main bearings as possible.

4. After the old flywheel housing has been removed, put the new one in place but do not tighten the fastening screws "A" (Illus. No. 21). The bolts "E" cannot yet be installed.
5. Fasten the fixture "H" (Illus. No. 24) to the crankshaft flange by means of bolts "D", with the gauge "C" (C. O. 63, Vol. 8) adjusted to the inner face of the housing as shown in Illus. No. 21.
6. Rotate the crankshaft slowly and note the variation on the indicator dial. Shift the housing to the right or left to obtain the lowest possible variation and thus center the housing as near as possible. Then tighten the screws "A" (Illus. 21) holding the housing to the crankcase and run a length of soft iron wire through the holes in the screw heads.

7. With a ½ inch standard reamer, ream the holes for bolts "B" (Illus. No. 21) at each side of the housing. Then put in the two bolts "B" and tighten the nuts.

8. Remove gauge "C" from fixture "H" (Illus. No. 21).

9. Turn the hand wheel "E" (Illus. No. 22) until the tool bit "F" has moved up and is in position to start the cut on the outer face of the housing. See that the edge of the tool bit is sharp and free from nicks.

10. Adjust the tool bit "F" (Illus. No. 22) by means of set screws "I" for a light cut across the face of the housing.

11. Remove the spark plugs.

12. Two men are required to operate the tool.

While one man is turning the crankshaft by means of the starting crank the other should stand at the tool and turn the hand wheel "E" (Illus. No. 22) slightly at each revolution. Care must be taken not to feed the tool too fast and just enough should be removed from the face of the housing to thoroughly clean up all around.

13. No adjustments are necessary to make the inner, or boring, cut.

Turn the hand wheel "E" until the tool bit "G" is in the position shown in Illus. No. 23. Then start the boring operation, being careful to shave off only light cuts.

14. With the extension micrometer (C.O. 425-2) measure the inner diameter frequently during the boring operation to avoid removing too much metal. See Illus. No. 25 for dimensions. The tool used need not be removed from the crankshaft flange to check the inner diameter.

15. The job can be checked by using the indicator gauge "C" as shown in Illus. Nos. 21 and 24.

If the machining operations have been carefully performed there should not be a variation of more than .001 inch.

16. The fixture can now be removed and the engine reassembled.

Tools Required—No. 21, 25 and 33 open end wrenches, screw driver, pliers, 9/16, 1/2, 11/16, 5/8 and 7/8 inch socket wrenches, hammer, punch, engine lifting hooks C.O. 119 and 120, chain hoist, engine stand, clutch flange aligning arbor C.O. 402, adjustable wrench, pail, Flywheel Housing Refacing and Boring Fixture C.O. 425, surface indicator, C.O. 63, soft iron wire, 1/2 inch reamer, 6 inch scale.

ARTICLE No. 44

To Install Air Cleaner on Cars Not So Equipped

1. Remove the present carburetor air heater pipe, air heater and exhaust pipe.

2. Place the front of pipe "B" in air heater "A" as shown in Illus. No. 72 and tighten the flange bolts. On the Special Six have the branch for the cold air by-pass pointing up.

3. Bolt the heater "A" to the exhaust manifold, making sure to have the rear end of pipe "B" placed in the carburetor air intake.

4. Install the new exhaust pipe "E" bolting it to the lower end of the heater "A".

A gasket must be used at both top and bottom flanges of the heater.

5. Place the air cleaner assembly "C" in position in the heater and tighten the clamp bolt. On the Special Six have the branch for the cold air by-pass pointing toward the branch in pipe "B".

6. On the Special Six, it will be necessary to install the cold air by-pass "D" as shown in (Illus. No. 72. This is not used on the Big Six.

Turn the valve in the by-pass to the closed position except during warm or hot weather.

Close the air temperature regulating valve in the carburetor air intake horn and fasten it securely by soldering. This must not be allowed to remain open or the benefit of the air cleaner will be lost.

Tools Required—No. 21, 25 and 27 open end wrenches, pliers, screw driver, hammer, soldering iron.

ARTICLE No. 45

To Install Gasoline Filter on Cars Not So Equipped

1. Close the valve at the vacuum tank outlet and remove the vacuum tank to carburetor pipe.
2. Drain all gasoline from the vacuum tank and then remove the valve at the outlet.
3. Screw the nipple "A" (Illus. No. 71) into the vacuum tank outlet.
4. Attach strainer "B" to nipple "A", making sure the nipple "C" is in place. The nipple "C" should point toward the carburetor.
5. Connect vacuum tank to carburetor pipe "D". Note in Illus. No. 71 that the pipe used on the Big Six is different from that used on the Special Six.
6. Open the valve in the top of the strainer. Put a quantity of gasoline in the vacuum tank through the plug in the top.

Tools Required—No. 23 and 27 open end wrenches, small pipe wrench, pliers.

ARTICLE No. 46

To Remove and Replace Gasoline Tank

1. Remove the drain plug at the bottom of the gasoline tank and drain the tank.
2. Disconnect the gasoline pipe at the gasoline tank.
3. Disconnect the gasoline gauge pipe at the gasoline tank.
4. Remove the bolt from the gasoline tank bracket at the front of the tank.
5. Remove the two bolts from the gasoline tank brackets at the rear of the tank.
6. The tank can be dropped down and removed.
7. Reverse operations to replace.

Tools Required—No. 21, 25 and 27 open end wrenches, adjustable wrench, pliers, pail.

ARTICLE No. 47

To Remove and Replace Vacuum Tank

1. Turn off the nut "Y" (Illus. No. 6) connecting the gasoline pipe with the top of the vacuum tank. Also the nut "Z" connecting the suction line with the intake manifold.
2. Remove the nut connecting the carburetor feed pipe "V" to the vacuum tank or gasoline filter and drain the gasoline from the vacuum tank.
3. Remove the outer nut at the right side of the intake manifold holding one side of the vacuum tank bracket.
4. Remove the two screws "B" (Illus. No. 6) holding the vacuum tank bracket to the intake manifold and remove the vacuum tank.
5. Reverse operations to assemble.

Tools Required—No. 23, 25 and 29 open end wrenches, pliers.

ARTICLE No. 48

To Remove and Replace Carburetor

1. Loosen the two clamp screws "X" and "W" (Illus. No. 6) holding the choke control tube and the choke wire to the carburetor. The tube and wire can now be disconnected from the carburetor.
2. Shut off the gasoline by means of the valve under the vacuum tank.
3. Disconnect the vacuum tank to carburetor feed pipe "V" (Illus. No. 6) at the carburetor.
4. Disconnect the hand throttle connection at

"F" and the foot accelerator connection at "E". (Illus. No. 6).

5. Remove the two flange bolts "G" holding the carburetor to the intake manifold and remove the carburetor.

6. Reverse operations to reassemble.

If the carburetor gasket is damaged install a new gasket.

Tools Required—Pliers, No. 23, 25 and 29 open end wrenches and screw driver.

ARTICLE No. 49

To Install New Float Valve Needle and Seat in Stromberg Carburetor

1. Remove the carburetor from the engine. (See Operation Article No. 48).
2. Remove the float cover and needle assembly.
3. Remove the needle valve cap.
4. Hold guide sleeve "A" and remove lock nut "B" (Illus. No. 84).
5. Hold the guide sleeve and screw out needle "I" (Illus. No. 85).
6. Take out the lock nut inside of the float chamber, at the same time holding the strainer body. (See Fig. 1, Illus. No. 78).
7. Remove the needle seat and strainer body assembly.
8. Reverse operations to assemble.

Adjust the needle by holding the guide sleeve and screwing the needle up or down until the travel between open and closed position is 5/64 of an inch. See page 49.

Tools Required—Pliers, screw driver, No. 23, 27 and 29 open end wrenches, 1/4 and 3/16 inch open end wrenches.

ARTICLE No. 50

To Install New Float Valve Needle and Seat in Ball and Ball Carburetor

1. Shut off the gasoline by means of the valve under the vacuum tank.
2. Remove the float chamber cover and float. (See Fig. 1, Illus. No. 75).
3. Disconnect the vacuum tank to carburetor feed pipe and allow the gasoline to drain from the carburetor.
4. Unscrew the float needle valve seat and remove it. Fig. 1, Illus. No. 75).
5. Reverse operations to assemble.

Always install the entire float chamber cover and needle valve assembly, as the collar is set on the stem at the factory to give proper float level.

Tools Required—No. 25 and 27 open end wrenches, pliers, 9/16 inch socket wrench.

ARTICLE No. 51

To Clean Stromberg Carburetor

1. Remove the carburetor from the engine. (See Operation Article No. 48).
2. Remove the float cover "D" and float "X" (Illus. No. 86).
3. Remove screen "W" from the strainer body.
4. Remove main discharge plug "Q".
5. Remove idler tube "U".
6. Remove high speed adjusting screw "F".
7. Remove accelerating well plug "T".
8. Blow out all passage ways with air.
9. To clean the accelerating well bleeder "A", use a wire as in Illus. No. 86 small enough to enter a No. 60 hole drilled through the casting just above the butterfly valve.
10. Reverse operations to reassemble.

Tools Required—Screw driver pliers, No. 25 and 29 open end wrenches, piece of ordinary tag wire and air line.

ARTICLE No. 49-1

To Install New Float Valve and Seat in Stromberg Carburetor

The following revision in Article No. 49 applies to Model TX-2.

1. Shut the gasoline off at the valve under the vacuum tank and disconnect the feed line at the carburetor.
2. Remove the three screws and lift off the float chamber cover "A" (Illus. No. 94).
3. Remove the pin "D" and then the float "B" and float needle "C" will be released.
4. Remove the needle valve seat "M".
5. Reverse operations to assemble.

Adjust the float if necessary by bending the float arm where it bends away from the float. The distance between the top of the float and the bottom face of the float chamber cover, when the needle is seated should be 7/32 of an inch.

Tools Required—Screw driver, pliers, and No. 21 open end wrench.

ARTICLE No. 51-1

To Clean Stromberg Carburetor

The following revision in Article No. 51 applies to Model TX-2.

1. Remove the carburetor from the engine. (See Operation Article No. 48).
2. Remove the Float cover assembly "A" (Illus. No. 94).
3. Remove the strainer connection "E" and clean the screen.
4. Remove the main discharge plug "I" and Jet "H".
5. Remove the high speed adjusting needle "K".
6. Remove the accelerating well bleeder "F".
7. Remove the idling adjusting needle "J".
8. Blow out all passage ways with air.
9. To clean the accelerating well bleeder passage, use a wire small enough to enter a No. 60 drilled hole through the casting just above the butterfly valve.
10. Reverse operations to assemble.

Tools Required—Screw driver, pliers, No. 25, 27 and 29 open end wrenches, piece of tag wire and air line.

Insert in Volume Three, after page 134.

ARTICLE No. 52

To Clean Ball and Ball Carburetor Previous to Model SV-33

1. Remove the carburetor from the engine (See Operation Article No. 48).
2. Remove float chamber cover "N" (Illus. No. 87) and float "K".
3. Remove strainer plug "E', screen "F" and strainer well "M".
4. Remove plug "A" which holds float chamber "L" to the carburetor. This also permits the removal of pick-up plunger "C" and spring "B".
5. With a screw driver, remove the idling metering screw "G" and step-up metering screw "H".
6. Remove first and second stage metering screws "I" and "J".
7. Unscrew and remove idling adjusting screw "D".
8. Blow out all passages with air and wash all parts thoroughly in clean gasoline.

Do not use drills to clean metering screws or jet orifices. These parts should either be cleaned with air or new ones installed.

9. Reverse operations to assemble.

Tools Required—Screw driver, pliers, No. 23, 27, 29 and 33 open end wrenches.

ARTICLE No. 53

To Clean Ball and Ball Carburetor, Model SV-33

1. Remove the carburetor from the engine (See Operation Article No. 48).
2. Remove two screws and remove float chamber cover "N" and float "M" Illus. No. 88).
3. Remove strainer plug "H", spring "B" and screen "C".
4. Unscrew the idling well plug "E" and with a screw driver remove the idling jet "J" along with the tube "I".
5. Remove the primary well plug "L".
6. Remove metering screws "D" and "G".
7. Remove idling adjusting screw "K".
8. Remove three screws and remove second stage bracket "O".
9. Blow out all passages with air and wash all parts thoroughly in clean gasoline.

Do not use drills to clean metering screws or jet orifices. These parts should either be cleaned with air or new ones installed.

10. Reverse operations to assemble.

Tools Required—Screw driver, pliers, No. 23, 27, 29 and 33 open end wrenches.

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Volume Six

TRANSMISSION AND CLUTCH

ALL MODELS

Unless otherwise specified the information given herein applies to all cars after Big Six serial number 2,060,001, Special Six serial number 3,120,001, Standard Six serial number 1,202,001, Bus Chassis serial numbers 2,070,600 and 3,173,001 and Erskine Six.

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BIG SIX, SPECIAL SIX AND BUS CHASSIS SECTION

DIAGNOSIS

The following pages of diagnosis will be found of material value in tracing the sources of difficulty. The main headings have been taken directly from indications of trouble, such as "Transmission Leaks Oil" or "Gears Sliding Out of Mesh." Under these have been listed the causes for such conditions. Even the most experienced mechanic will find that such a list will often serve to jog his memory on causes which are infrequently encountered. Sections on "Test" and "Remedy" then follow except in a few cases where these items are so apparent as to need no explanation. In case more detailed information on any subject is required the General Information Section starting on page 15 or the Operation Articles starting on page 41

TRANSMISSION

Transmission Leaks Oil

Cause

1. Too much oil or wrong grade of oil in transmission.
2. Damaged or missing gaskets.
3. Loose operating valve or piston packing nuts or worn packing. (Hydraulic brake transmission).
4. Damaged pinion bearing oil throw ring or stopped up oil return groove in transmission case front flange.
5. Broken or cracked transmission case.

Test

1. Check the oil in the transmission to see that it is not above the level of the filler plug on the left hand side of the transmission case.

See that the proper grade of oil is being used. See "Remedy,"item 1.

2. In determining the source of a leak the transmission case should first be cleaned off so that the exact location can be seen.

If oil is leaking from gaskets it is advisable to try tightening all bolts. If this does not stop the leak disassemble and examine the gaskets.

Solid copper gaskets instead of lock washers should be under the screws holding the pump housing cover, the cylinder covers and the transmission front flange.

3. If oil is seen to drip from the operating valve or brake pump piston packing nuts, test the packing nuts to see if they are tight. If the leak is not due to loose nuts, the packing probably needs renewing.

4. If oil seems to be leaking out at the front end of the transmission, remove the hand hole cover in the bell housing and wipe off the oil which has leaked out. Then start the engine and observe the point from which the oil flows. It may be necessary to run the car for this purpose.

If oil is seen to leak out at this point, remove the transmission and take off the front flange. Examine the spiral oil groove for heavy grease which would clog it and prevent the transmission oil from returning to the case.

If this groove is open, remove the transmission pinion and inspect the oil throw ring. Also examine the return hole in the transmission case.

5. Clean the outside of the transmission case thoroughly and examine for cracks.

Remedy

1. If the leak is due to too much oil in the transmission, remove the drain plug and allow the oil to drain out until level with the filler plug on the left-hand side of the case.

If the improper grade of oil is being used in the transmission, drain it and fill with the correct grade.

Fill the hydraulic brake transmission to the level of the filler plug with medium engine oil in warm weather and light, *cold test* engine oil in cold weather. (Use only ENGINE OIL in the hydraulic brake transmission).

Fill the transmission on cars having mechanical brakes, with a light transmission grease or very heavy transmission oil. In cold weather replace 25 per cent. of this with heavy engine oil.

2. Install new gaskets where broken or damaged. If the screws mentioned under "Test," No. 2, have no gaskets, remove the lock washers and install solid copper gaskets instead. When replacing the transmission front flange gaskets, put white lead on both gaskets to make the joint oil tight.

3. Install new packing if worn. When installing new packing, wrap it around the shaft so that the end next to the packing nut will point in the same direction that the nut is turned to tighten.

4. If the spiral groove in the flange is filled with grease, this may be the result of applying too much grease in the clutch shifter bearing. If the flange has a 3/8 inch hole in its side one of the new type without the hole should be installed. This will help to keep out excess grease from the shifter bearing.

A new oil throw ring should be installed if the one in the assembly is damaged.

5. If the transmission case is broken or cracked install a new case. (See Operation Article No. 4, to remove and replace).

Transmission Noisy in Neutral After Car Has Been Driver 1500 Miles or More

Cause

1. Lack of lubrication or lubricant too thin or too thick.
2. Pinion bearing rough, broken or badly worn.
3. Main shaft pilot bushing badly worn.
4. Drive pinion teeth or teeth on countershaft drive gear badly worn or broken.
5. Excessive wear at countershaft and reverse idler gear bushings.
6. End play in pinion shaft, resulting from:
   Bearing locking nut loose.
   Excessive wear at pinion bearing. (See "Test" and "Remedy" No. 2).

Test

1. Check the transmission to see if it is filled to the level of the filler plug with the proper grade of oil. See "Remedy" No. 1.

If it is found that the transmission case is filled with the proper grade of oil it will be necessary to remove the transmission assembly from the car (See Operation Article No. 4), disassemble and examine it for the following causes:

Examine the bearing locking nut "D" (Illus. No. 16) on the pinion shaft to see if it is loose. If the nut is loose, examine the locking washer "E". A loose locking nut or badly worn bearing will result in end play in the pinion shaft, as given under "Cause" No. 6.

2. Disassemble and examine the pinion bearings "C" (Illus. No. 16) to see if it is rough, broken or badly worn.

3. See if the bushing in the pinion shaft carrying the front end of the main shaft is badly worn. This can be tested by placing the main shaft in position in the bushing and testing for play.

4. Examine the drive pinion teeth and the teeth on the countershaft drive gear "C" (Illus. No. 19) to see if they are worn or damaged. Also look for pieces of metal between the teeth on all gears.

5. After disassembling the transmission, slide the countershaft gears "F" (Illus. No. 20) on to the countershaft "E" and test for play in the bushings. Test the bushings in the idler gear for wear in a similar manner.

6. See "Test" No. 2.

Remedy

1. If the transmission is noisy due to lack of lubricant, fill it to the level of the filler plug.

Fill the hydraulic brake transmission with medium engine oil in warm weather and light *cold test* engine oil in cold weather. (Use only ENGINE OIL in the hydraulic brake transmission).

Fill the transmission on cars with mechanical brakes with a light transmission grease or very heavy transmission oil. In cold weather replace 25 per cent of this with heavy engine oil.

2. Bearings which are not broken or pitted but feel rough when revolved can usually be cleaned with gasoline. If the bearing is worn or damaged install a new one. A new bearing, before being installed, should never be cleaned, but care in handling after unwrapping must be exercised so that no dirt gets in the bearing. If the bearing locking washer "E" (Illus. No. 16) is damaged and the nut "D" is loose, install a new washer. Tighten the nut and lock securely by bending two lugs of the washer as shown in Illus. No. 15.

To install a new bearing, follow Operation Article No. 8.

3. Wear on the main shaft pilot bushing should be very slight. In case of excessive wear due to lack of lubrication or long usage, install a new bushing. If the shaft is worn so that the new bushing does not eliminate the play it will be necessary to install a new shaft.

4. If the drive pinion or countershaft gears are worn or broken it will be necessary to install new gears. If the transmission is noisy due to chips of metal having lodged between the teeth and no damage has resulted, clean the case and gears thoroughly and reassemble.

5. In case of excessive wear at the countershaft or reverse idler gear bushings, install a new bushing and shaft if necessary.

Transmission Noisy in High Gear

Cause

1. See all items except No. 3 under "Transmission Noisy in Neutral," page 7.

2. Main shaft rear bearing rough, broken or badly worn.

Test

2. Examine the bearing locking nut "H" (Illus. No. 18) on the shaft "A" to see if it is loose. If the nut is loose, examine the locking washer "G".

Remove the main shaft and bearing assembly from the transmission. Disassemble and examine the bearings to see if it is rough, broken or worn. (See Operation Article No. 11).

Remedy

2. If the bearing is not broken or pitted but feels rough when revolved, this condition can usually be remedied by washing the bearing thoroughly in gasoline. If the bearing is worn or damaged install a new one. A new bearing, before being installed, should never be cleaned, but care in handling after unwrapping must be exercised so that no dirt gets in the bearing. If the bearing locking washer "G" (Illus. No. 19) is damaged and the nut "H" is loose, install a new washer. Tighten the nut and lock securely by bending two lugs of the washer as shown in Illus. No. 18.

To install a new bearing, follow Operation Article No. 11.

Gears Sliding Out of Mesh

Cause

1. Gear shift lock plunger springs weak or broken.

2. Gear shift lock plungers on groove in gear shift rod worn.

3. Gear shift forks improperly lined up.
4. Excessive wear at main shaft front bushing.
5. Sliding gear or countershaft gear teeth worn.
6. Sliding gears loose on main shaft.

Test

1. Remove the gear shift lock plunger spring retainer nuts "C" and "L" (Illus. No. 8). Remove the springs "D" and "K" and examine them to see if they are broken or weak. They should have a tension of 14 to 19 pounds when compressed to a length of 1⅜ inches. However, they will operate satisfactorily with even less tension if other conditions in the transmission are correct.

2. Remove and examine the gear shift lock plungers 'E" and "J" (Illus. No. 8). The lock plungers should have a tapered point. This point being worn off flat may allow the gears to slip out of mesh.

The gear shift rods "F" and "I" (Illus. No. 8) must be removed in order to check accurately the condition of the grooves. If the sides of the grooves are rounded and worn the results will be the same as with worn lock plungers.

3. Remove the gear shift base assembly (See Operation Article No. 1) and examine the shift fork clamp screws to see if they are loose.

If the forks "B" and "M" (Illus. No. 8) are sprung it means that when the gear shift lever is in position for a certain speed (low, reverse, intermediate or high) the sliding gear is not in full mesh and consequently may pull out of mesh under a load.

Alignment of the forks may be tested by placing the gear shift base assembly in position, putting in two bolts at opposite corners, and placing the shift lever in the low speed position. Push the car forward just far enough to take up all the backlash in the gears and hold them tightly in position and apply the parking brake.

Remove the two bolts and take off the base assembly. If the low and reverse sliding gear is in full mesh with the countershaft gear then the shifting fork is properly lined. Repeat the test in reverse, intermediate and high speeds.

4. To test for wear at the main shaft pilot bushing, remove the gear shift base assembly (See Operation Article No. 1). Play in the bushing may be felt by moving the front end of the main shaft up and down and sideways with the hand.

5. Examine the sliding gear and countershaft gear teeth. Lack of lubrication, long usage or improper shifting of gears may cause the gear teeth to wear excessively. This condition may cause them to jump out of mesh.

6. The sliding gears should fit the shaft so they will slide freely and at the same time fit close enough to prevent rocking or tilting on the shaft.

Remove the gear shift base assembly and check the gears to see if they are loose on the shaft.

Remedy

1. Install new gear shift lock plunger springs if worn or broken.

2. In case of excessive wear on the gear shift lock plungers, or rods, install new parts. (See Operation Article No. 3).

3. If the shift forks are out of line, remove the gear shift base assembly (See Operation Article No. 1) and bend the forks to the correct position so that the gears are in full mesh when the gear shift lever is in position for a certain speed (low, reverse, intermediate or high). It may be necessary to remove and replace the gear shift base assembly several times, each time bending the forks slightly until the correct position of gears is obtained. Be sure both sides of the fork touch the gear at the same time.

4. Wear on the main shaft front bushing should be very slight. In case of excessive wear due to lack of lubrication or long usage, install a new bushing. If the shaft is worn so that a new bushing does not eliminate the play it will be necessary to install a new shaft. (See Operation Article No. 11).

5. Excessive wear on the countershaft gear or sliding gear teeth will necessitate installation of new gears. (See the Operation Articles for this).

6. A sliding gear loose on the main shaft can sometimes be remedied by merely assembling the gear on the shaft in a different position.

If gears are loose on the shaft due to excessive wear it will be necessary to replace the sliding gears giving trouble and possibly the main shaft. Match up the gear and shaft to a proper fit. Transmission shafts and high and intermediate sliding gears can be obtained from service stock already matched and should always be obtained when both parts are to be replaced.

The sliding gears should fit the shaft so they will slide freely and at the same time fit close enough to prevent rocking or tilting on the shaft.

CLUTCH

Clutch Slipping

Cause

1. Clutch friction discs worn, resulting from:
   Improper adjustment of toggle levers.
   Driving with foot resting on clutch pedal.
   Clutch pedal improperly adjusted, allowing it to strike under side of the toe board and hold clutch released.
2. Clutch springs weak or broken.
3. Grease or oil on clutch.

Test

1. If the clutch is slipping it is advisable to first check the pedal adjustment. See that there is not less than ⅛ of an inch clearance between the under side of the toe board and the clutch pedal arm.

Check the clutch toggle lever adjustment as follows:

Remove the toe board and remove the plate over the hand hole in the transmission bell housing. Press the clutch pedal and place C.O. 407 gauge (See Vol. 8) between the transmission case flange and the clutch shifter bearing housing at point "A" (Illus. No. 20). Test the three toggle levers "F" (Illus. No. 21) by hand. If properly adjusted there will be no clearance between the toggle levers "F" and shifter bearing "G". The toggle levers should not be tight but should each be just in contact with the shifter bearing.

If after making the tests just mentioned, no reason for the clutch slipping has been located it will be necessary to disassemble the clutch (See Operation Article No. 17) and examine the friction discs for excessive wear.

2. Before assembling the clutch examine it for weak or broken springs. Clutch springs in serviceable conditions should compress to a length of two inches under pressure of 145 to 155 pounds.

3. Examine for grease or oil on the friction discs and inner and outer plates.

Remedy

1. If the clutch requires adjustment, refer to Operation Article No. 20.

In case of excessive wear on the driving flange friction discs, install new discs (See Operation Article No. 18).

2. If the clutch springs are weak or broken, install new springs (See Operation Article No. 17).

3. Wash all parts thoroughly in gasoline before assembling. Also see instructions regarding oil leaks on page 17 and also in Volume 3. The cause of the oil or grease getting into the clutch should be removed before reassembling.

Clutch Grabbing

Cause

1. Uneven adjustment of toggle levers.

Test

1. To test the clutch toggle lever adjustment, see No. 1 "Test" under "Clutch Slipping."

Remedy

1. If the test shows uneven adjustment of the toggle levers, see Operation Article No. 20.

Clutch Spinning

Cause

1. Clutch improperly adjusted.
2. Clutch pilot bearing dry or damaged.

Test

1. To test the clutch toggle lever adjustment. See "Test" No. 1 under "Clutch Slipping."

Also check the pedal adjustment to see that the clutch has a full 5 inches of travel. On cars with mechanical 4-wheel brakes, the pedal travel should be 5½ inches.

2. If the adjustment is found to be correct it will be necessary to disassemble the clutch. (See Operation Article No. 17) Examine the pilot bearing in the crankshaft to see if it is dry or damaged. While the clutch is disassembled it is advisable to test the sixteen bolts in the clutch driving flange hub flexible disc (if the clutch is of the type having a flexible disc) to see that they are tight.

Remedy

1. If the clutch or the clutch pedal is improperly adjusted, see Operation Article No. 20.
2. If the pilot bearing in the crankshaft is dry pack it with vaseline. If the bearing has been damaged install a new one.

In case the bolts in the clutch driving flange hub flexible disc are found loose, tighten them securely, peening the ends of the bolts so that the nuts cannot come loose again.

If the car has been run for some time with these nuts loose it may be necessary to install a new disc, as the holes in the disc may be damaged.

Clutch Shifter Bearing Noisy

Cause

1. Improper clutch pedal adjustment or driving with foot on clutch pedal.
2. Lack of lubrication or dirt in lubricant.
3. Worn or broken bearing.

Test

1. The design of the clutch shifter mechanism

is such that the shifter bearing does not turn unless pressure is placed on the clutch pedal. The play in the clutch pedal allows it to be held back out of engagement with the toggle levers.

Check the pedal adjustment as described under that there is not less than ⅛ of an inch clearance between the under side of the toe board and the "Test" No. 1, "Clutch Slipping." See that clutch pedal arm and that the pedal arm has a full throw of 5 inches. On cars with mechanical 4-wheel brakes the pedal travel should be 5½ inches.

2. To test for a dry bearing, apply grease to the bearing to see if this will elminate the noise.

3. If after being lubricated the bearing is still very noisy, remove and examine it. (See Operation Article No. 5).

Remedy

1. If the noise is due to improper clutch pedal adjustment, see Operation Article No. 20, the driver should be cautioned against the practice of resting his foot on the clutch pedal.

2. Grease the shifter bearing by means of the grease cup on the right hand side of the transmission bell housing with a good grade of cup grease. Be careful in greasing this bearing, not to force in so much that it will work out on the clutch, causing it to slip. Ordinarily about three turns of the grease cup will be sufficient. However, if the bearing is totally dry, more may be required.

3. Install a new shifter bearing. (See Operation Article No. 5).

Pedals Vibrate

Cause

1. Leather washer missing, worn or improperly spaced (last item does not apply to cars having floating type of washer).

Test

1. If pedal leather washers are missing, or improperly spaced a slight vibration at pedals may cause them to strike the metal toe plates and result in a rattle. This can be tested with the hand.

Remedy

1. Loosen the pedal plate and centralize the washers (does not apply to cars having floating type washer.) If this does not remedy the rattle install new washers.

GENERAL INFORMATION

The following section is one containing information of a general nature and may be used to supplement the Diagnosis and Operation Article Sections. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised paragraph will be carried at the bottom of the green sheet.

For example, the reader is interested in paragraph 1-A Transmission Case. Before he reads this, a glance at the bottom of the page will tell him whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the paragraph number 1-A such as 1-A-1 or 1-A-2 then he knows that the information on the green sheet must also be read to get the complete instructions.

TRANSMISSION

1-A—Transmission Case

Replacement of a transmission case is usually made necessary by breakage or stripped threads.

Care should be exercised in drawing up cap screws, not to turn them too tight. Also see that they are free from burrs and dirt which would tear the threads in the case. If any of the threads are stripped, it is usually possible to tap the case for the next size larger screw. The only other alternative is to install a new case. When tapping the case for larger screws always tap for coarse (U.S.S.) threads.

A case is broken as a rule by rough handling, a piece of metal wedging between the gears and the case or by the fastening bolts not being kept tight.

2-A—Adjustment of Bearings

The transmission shaft and pinion are carried on ball bearings. No provision is made for adjustment and under normal conditions it is not possible for any end play to develop.

The bearings are held in place by means of nuts screwed on the shafts and any end play in the shafts means that these nuts were not screwed up tight or else were improperly locked so that they loosened up.

The countershaft is provided with thrust washers, which can be replaced to remove excessive end play.

3-A—Bearings Rough or Broken

Rough or broken bearings are usually caused by lack of lubrication or dirt and grit in the lubricant. See "Lubrication and Cleaning of Transmission," below.

Bearings which are not broken or pitted but feel rough when revolved can usually be cleaned with gasoline. New bearings, before being installed, should never be cleaned, but care in handling after unwrapping must be exercised so that no dirt gets in the bearing.

To install new bearings, follow Operation Article No. 8 or 11, using a new bearing when assembling.

4-A—Lubrication and Cleaning of Transmission

Use only ENGINE OIL in the transmission on hydraulic brake equipment. Oil should stand at the level of the filler plug in the left hand side of the case.

Medium engine oil should be used in warm weather and light, *cold test* oil in cold weather.

On mechanical brake equipment use light transmission grease or very heavy transmission oil. In cold weather replace 25 per cent of this with heavy engine oil.

Care should be taken not to allow grit and dirt to get into the lubricant. However, with constant use a certain amount of very small metallic particles will collect in the lubricant and for this reason the transmission should be thoroughly cleaned out twice each year.

To clean out the transmission remove the plug in the bottom of the case, and drain out the old oil. Then remove the gear shift assembly (See Operation Article No. 1) and wash the case and all parts thoroughly with kerosene or gasoline.

Replace the gear shift assembly and plug and fill the case with oil of the proper grade to the level of filler plug.

5-A—Gears Worn or Broken

If the car is driven where there is a large amount of first and second speed work there is necessarily a heavy strain placed on the gears, and they will show a corresponding amount of wear. Incorrect or insufficient lubrication will also cause rapid wear.

Broken gears can usually be traced to overloading, sudden application of power (such as is experienced with a grabbing clutch or when engaging the clutch suddenly, with the engine running beyond normal speed) or pieces of metal getting between the gear teeth.

When replacing a worn or broken gear, examine the other transmission gear, particularly the ones which mesh with it and replace them if necessary.

6-A—Gears Loose on Main Shaft

The sliding gears should fit the main shaft so that they will slide freely and at the same time fit close enough to prevent rocking or tilting on the shaft.

If the sliding gears are loose on the shaft they will probably slip out of mesh with the countershaft gears. If it is the high and intermediate

gear which rocks on the shaft it will also cause excessive backlash in the transmission line. To overcome the backlash try assembling the gear in a new position on the shaft. If the rocking still exists after testing by hand install a new gear which fits the shaft or install a matched shaft and gear.

If the above condition is found to be causing gears to slip out of mesh it will be necessary to replace the sliding gears "C" and "D" (Illus. No. 19) and possibly the main shaft "A". It will at least be necessary to match up the gear and shaft to a proper fit.

7-A—Gear Shift Fork Out of Line

The gear shift forks "B" and "M" (Illus. No. 8) sometimes become sprung by the driver attempting to force gears into mesh and also by rough handling of the gear shift base assembly when off the transmission.

If the forks are sprung the result is that the sliding gears do not fully mesh with the countershaft gears and consequently may not stay in mesh.

The forks should be lined up so that the gears are in full mesh when the gear shift lever is in position and so that shift fork pads "B" and "M" (Illus. No. 8) are in line and touch the gear hub on both sides at the same time.

To line up the forks remove the gear shift base assembly and bend the forks to the correct position. See "Diagnosis," page 8.

CLUTCH

1-B—Clutch Adjustment

All new cars received by the dealer should be checked for proper clutch adjustment. After the first 500 to 1000 miles, the clutch should again be examined and any necessary adjustments made.

To obtain proper adjustment, adhere strictly to instructions in Operation Article No. 20.

2-B—Clutch Friction Discs

Never place the foot on the clutch pedal except when the clutch is to be released. As mentioned in the "Diagnosis," Page 10, this is a frequent cause of slipping clutch and worn friction discs.

Excessive wear on the inner and outer plates "A" and "C" (Illus. No. 23) may be caused by failure to properly countersink the rivets when replacing the friction discs. (See Operation Article No. 18).

3-B—Clutch Springs

The clutch springs should compress to a length of two inches under pressure of 145 to 155 pounds. If they are found to be weak they should should be replaced with new ones. However, springs are often thought to be weak whereas the difficulty may be incorrect clutch adjustment or worn friction discs.

4-B—Clutch Oil Soaked

The clutch discs are designed to run absolutely dry and the presence of any oil or grease will cause them to slip.

About the only way that oil or grease could get on the clutch is from a leak at the rear of the engine, a leak in the front end of the transmission, or through an oversupply to the clutch shifter bearing. If the latter difficulty seems to be the case, the owner should be cautioned against turning the shifter bearing grease cup more than two or three turns at one time.

To clean oil or grease from the clutch, it will be necessary to disassemble it (See Operation Article No. 17) wash all parts in gasoline and dry thoroughly before reassembling. Do not attempt to flush out the clutch with gasoline or kerosene.

5-B—Clutch Driving Flange

On cars which have the fabric disc incorporated in the clutch driving flange (Illus. No. 26) it is important that the bolts holding the hub and flange to the disc be kept tight.

If the bolts are allowed to loosen, the bolt holes will be rapidly enlarged.

6-B—Clutch Shifter Bearing

Wear or breakage of the shifter bearing is ordinarily caused by lack of lubrication, dirt in the lubricant or driving the car with the foot resting on the clutch pedal.

The design of the clutch shifter mechanism is such that the shifter bearing does not turn when the clutch pedal is released. The play in the clutch allows it to be held back out of engagement with the toggle levers. Driving with the foot on the clutch pedal brings the bearing into contact with the toggle levers. This puts it constantly in motion causing considerable extra wear.

To remove and replace the clutch shifter bearing, see Operation Article No. 5.

1-B-1—Clutch Adjustment

The adjustment of the Long Clutch, which entered production in the Commander and President Models at Serial Nos. 4,000,001 and 2,116,-678 is limited to the clutch pedal only.

The design of the new clutch includes a driving flange which is slightly dished to impart smoothness and flexibility to the operation of the car.

These clutch assemblies are adjusted and locked at the factory and no adjustment of the clutch toggle fingers should be attempted under any conditions. The clutch driven flange assembly should always be serviced as an assembled unit. No repairs should be attempted by the dealer. Units needing repairs should be returned to the factory.

See Operation Article No. 20-1 to adjust the clutch pedal.

Insert in Volume Six, Big Six Section, after page 18.

TOLERANCE CHART

The chart on the following page is for your convenience in repair work. It will give you definite information as to the serviceability of parts subject to wear and distortion.

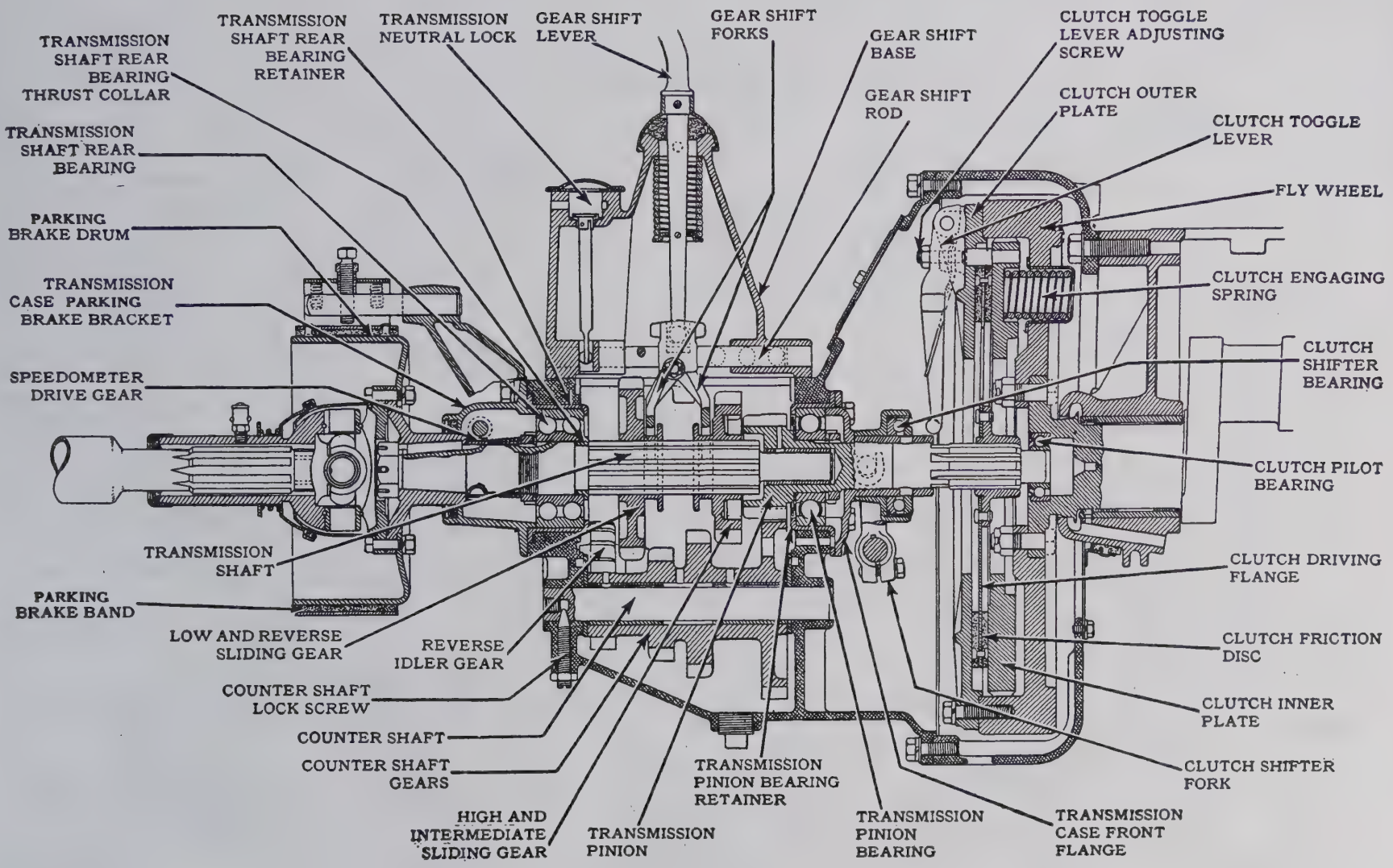
Considerable judgment must be exercised in its use, however, and any decision based on this data must be tempered by individual conditions and the wishes of the car owner.

For example, the maximum backlash between the transmission gear teeth is given as .015 of an inch. This means that, when overhauling the transmission to put the assembly in first class condition, parts having clearance up to this amount may be considered serviceable, while those with greater clearance must be replaced to obtain a first class job. However, this is not to be interpreted as meaning that gear teeth with greater clearance are totally unfit for service. The thoroughness of the overhaul as specified by the owner should determine this.

Insert in Volume Six, Big Six Section, after page 20.

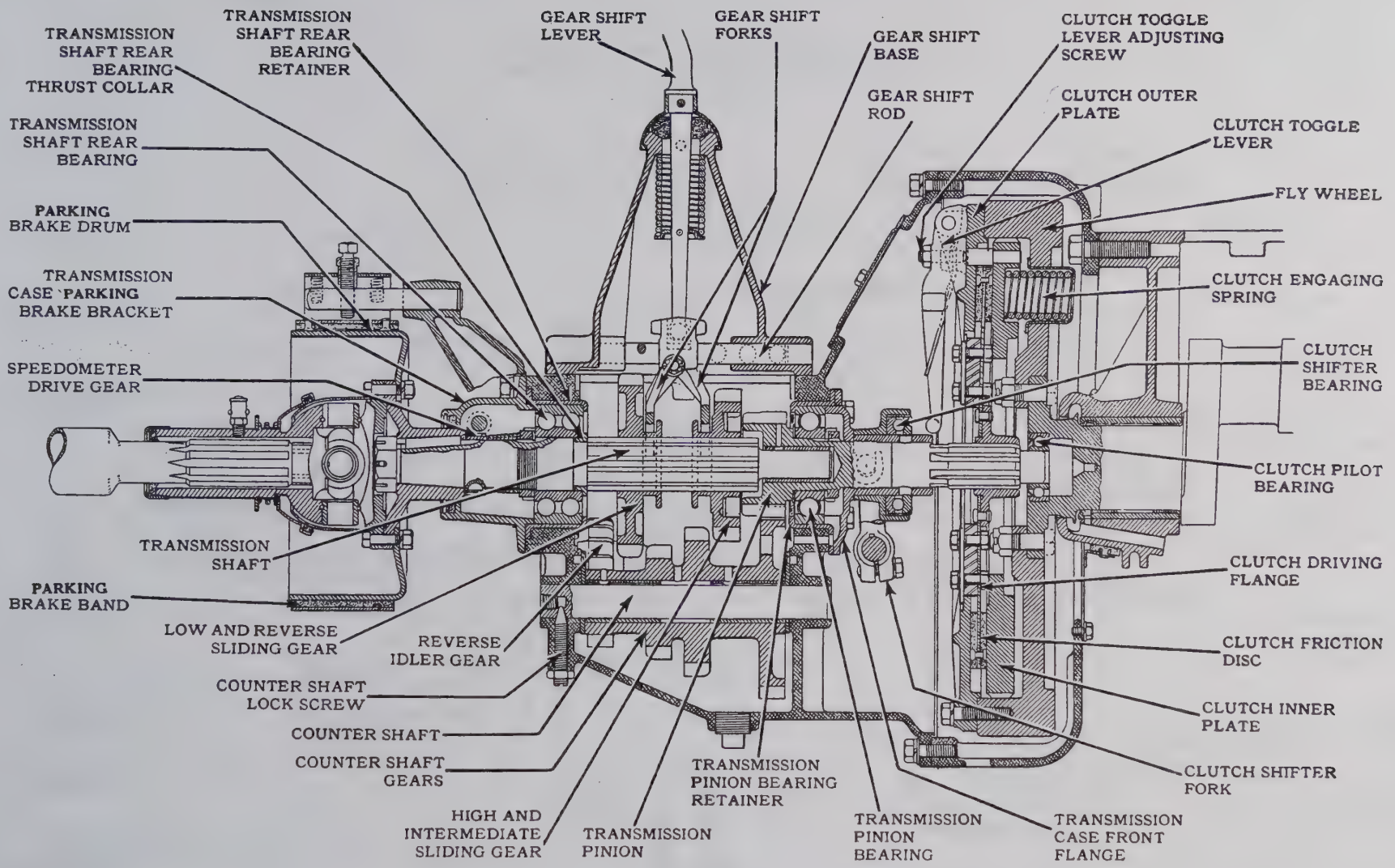
	Tolerance For New Parts		Tolerance For Parts In Service
	MIN.	MAX.	MAX.
Gear Shift Rod			
Alignment			.002″
Roundness			.003″
Clearance in gear shift base	.0005″	.0035″	.005″
Gear Shift Rod Lock			
Length			63/64″
Tension of spring (when compressed to 1-3/8″)	14 lbs.	19 lbs.	No. Min. Limit
Clutch Flange			
Alignment (when centered through hub and tested near outer edge)	.000	.005″	.005″
Clutch Shifter Shaft			
Alignment	——	——	.005″
Clearance in transmission case	.003″	.005″	.009″
Roundness	——	——	.005″
Clutch Shifter Arm Pin			
Roundness	——	——	.005″
Clearance in shifter arm bushing	.0005″	.0015″	.008″
Clutch Engaging Spring			
Tension (when compressed to 2″)	145 lbs.	155 lbs.	135 lbs.
(Bus type spring)			
Tension (when compressed to 1-15/16″)	170 lbs.	180 lbs.	160 lbs.
Transmission Pinion			
Alignment	——	——	.0015″
Backlash in clutch flange	.002″	.003″	.005″
Backlash in clutch flange (Commander models)	.001″	.004″	.006″
Transmission Shaft			
Alignment	——	——	.002″
Clearance of pilot in pinion bushing	.001″	.003″	.007″
Backlash of shaft in sliding gears	.005″	.0035″	.005″
Counter Shaft			
Alignment	——	——	.0015″
Clearance in bushings	.001″	.0025″	.006″
Roundness	——	——	.005″
Endplay of gears	.003″	.008″	.020″
(Commander models)			
Clearance in bushings	.002″	.0035″	.008″
Endplay in gears	.003″	.017″	.025″
Gears			
Backlash between teeth	.007″	.010″	.015″
Reverse Idler Gear Shaft			
Roundness	.0005″	.0015″	.003″
Clearance in bushing	.002″	.0035″	.005″
Endplay of gears	.005″	.015″	.022″
Gear Shift Lever Spring			
Tension (when compressed to 2½″)	44 lbs.	52 lbs.	35 lbs. Min.

ILLUSTRATIONS



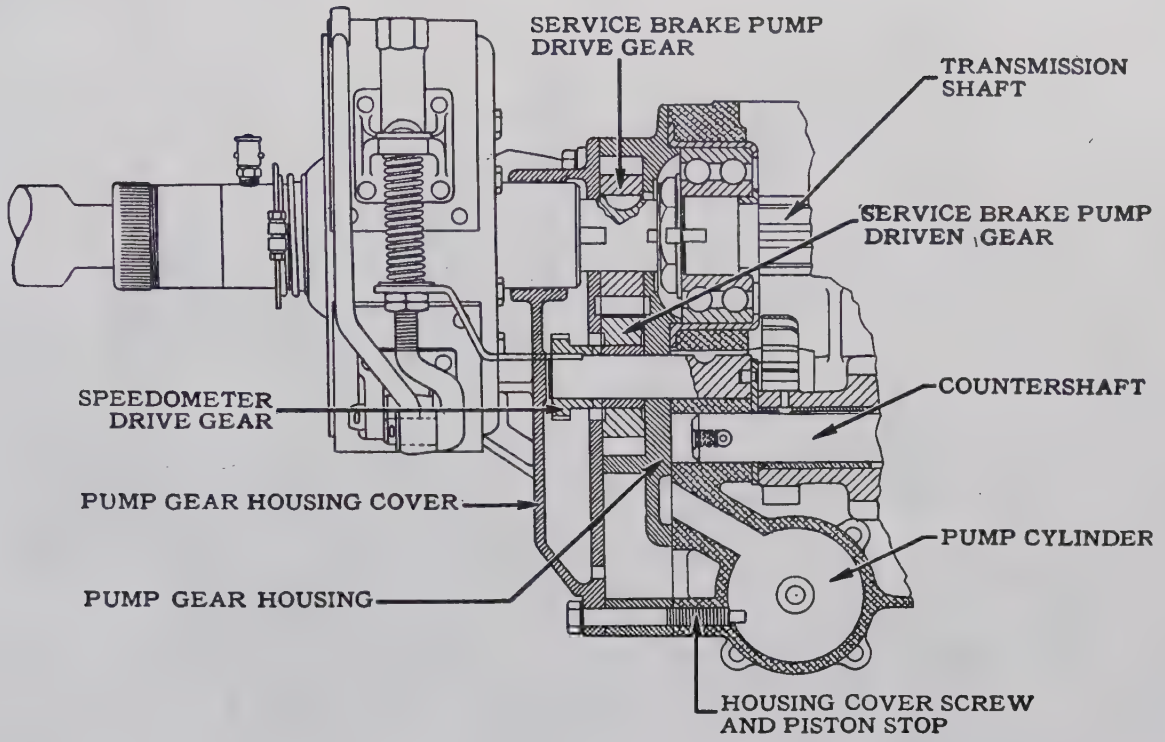
Illus. No. 1

Longitudinal Section Through Transmission
(Mechanical Brakes)

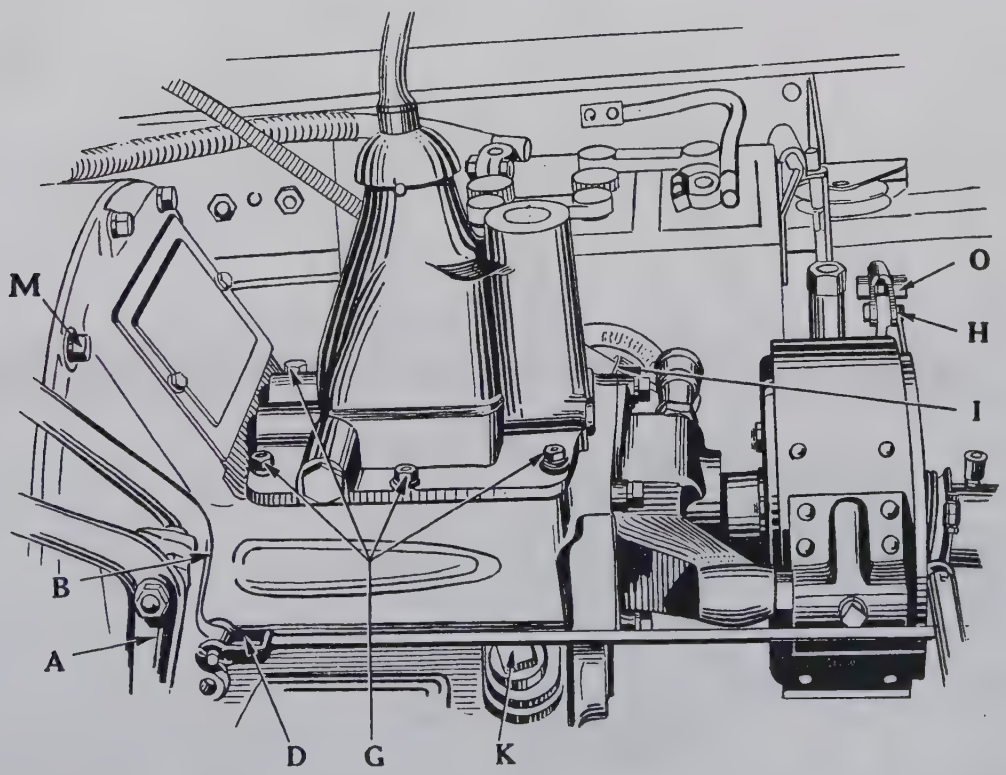


Illus. No. 2

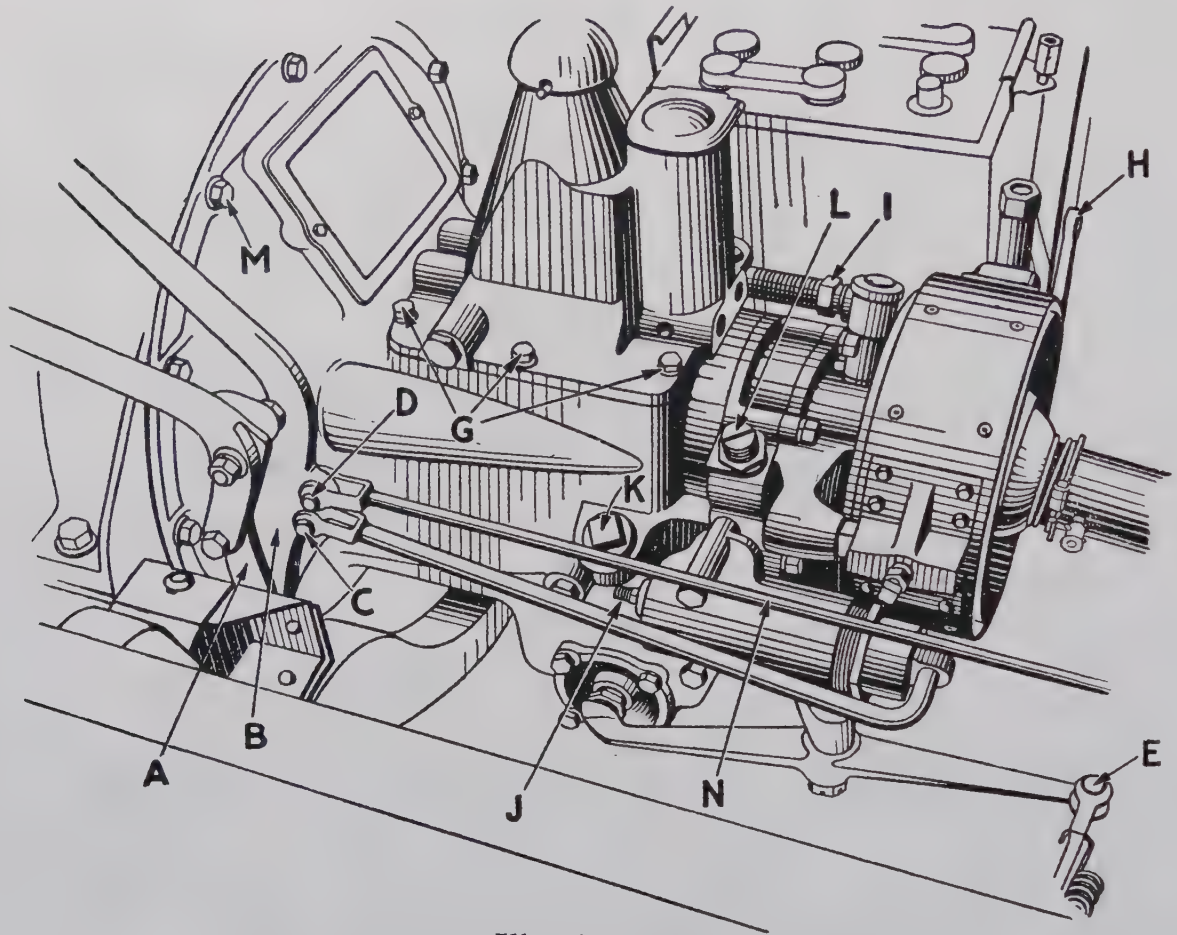
Longitudinal Section Through Transmission (Mechanical Brakes)



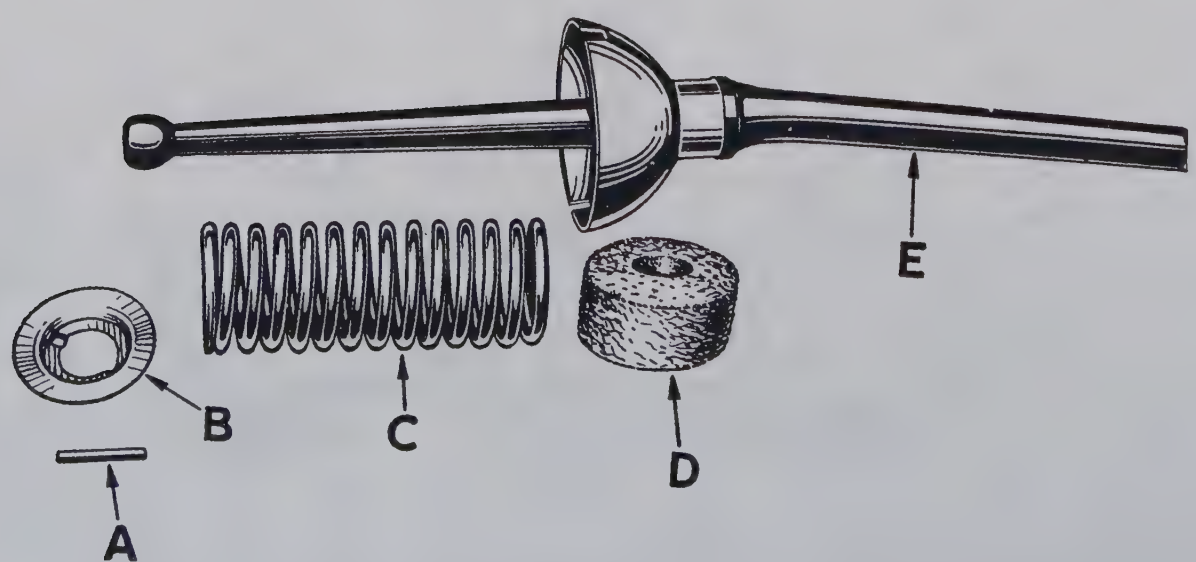
Illus. No. 3
Longitudinal Section Through Rear End of Transmission (Hydraulic Brakes)



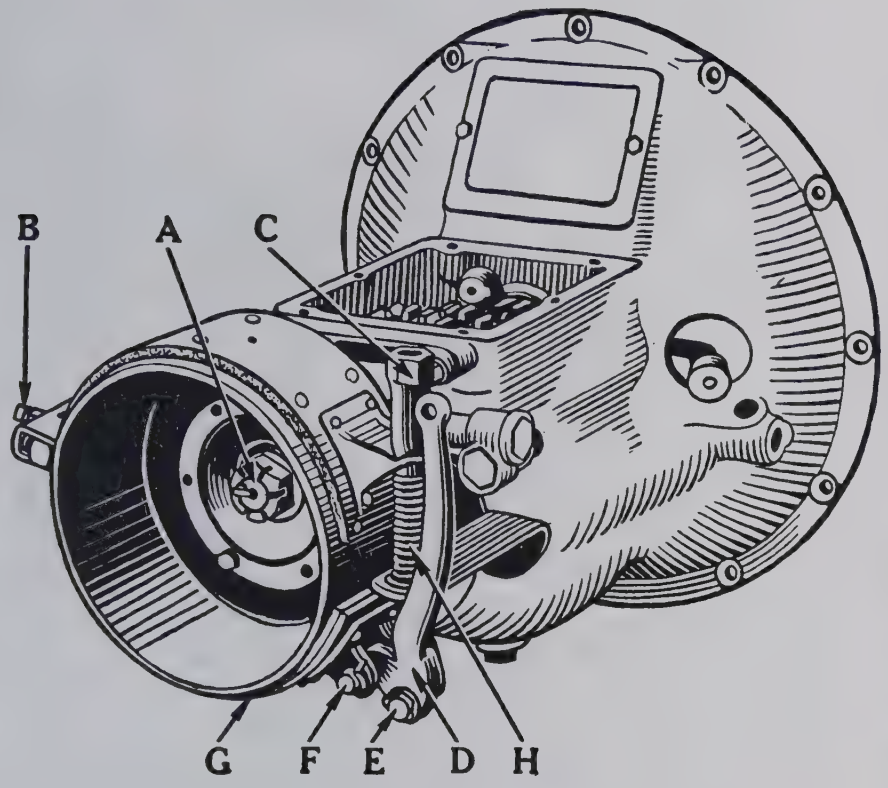
Illus. No. 4
Left-Hand Side of Transmission Assembled in Chassis (Mechanical Brakes)



Illus. No. 5
Left-Hand Side of Transmission
Assembled in Chassis
(Hydraulic Brakes)

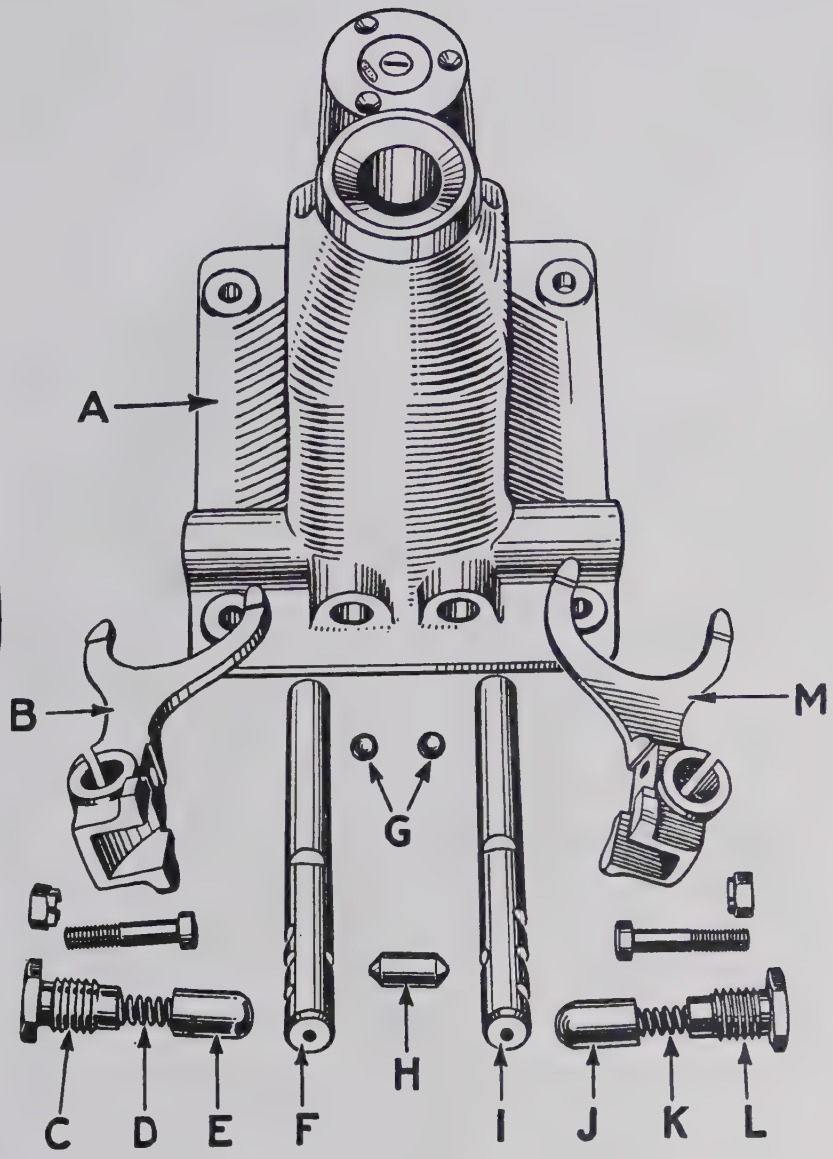


Illus. No. 6
Gear Shift Lever



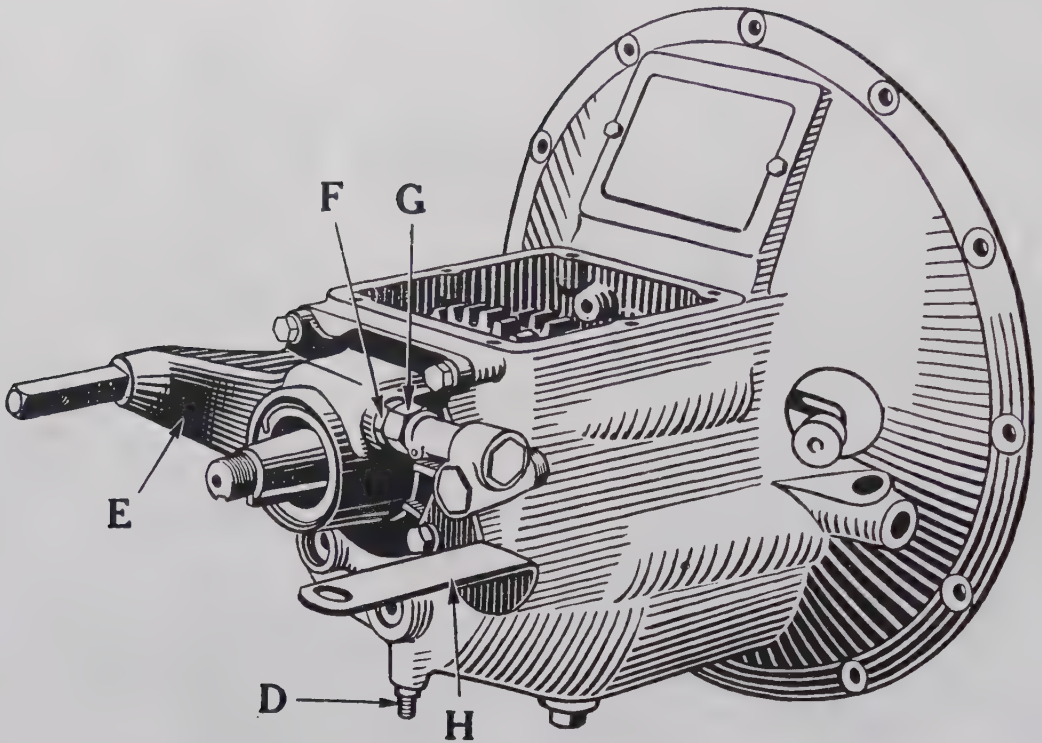
Illus. No. 7

Rear End of Transmission Assembly
(Mechanical Brakes)

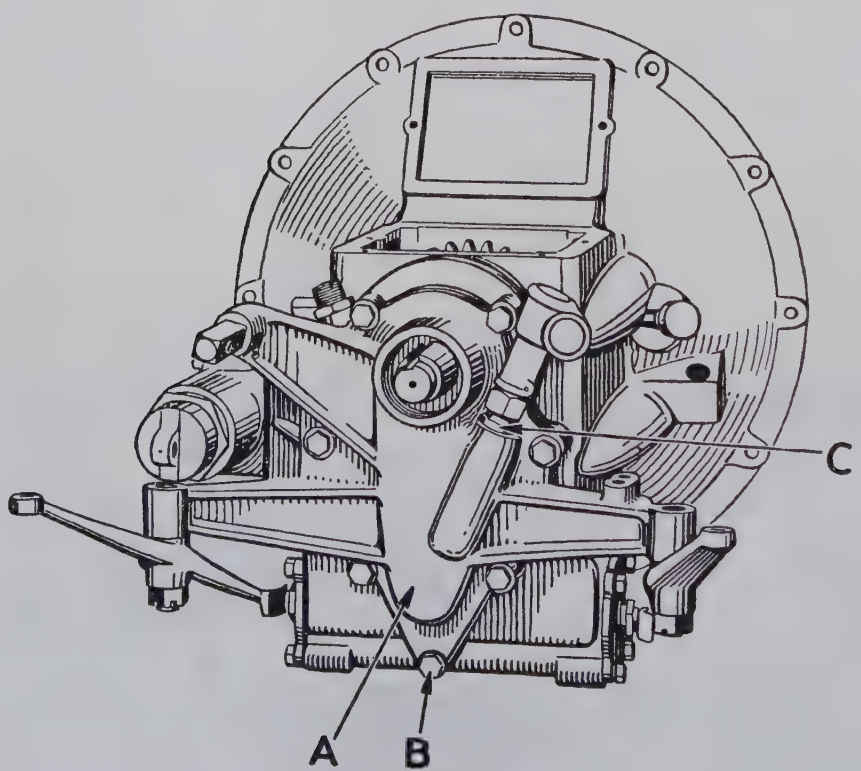


Illus. No. 8

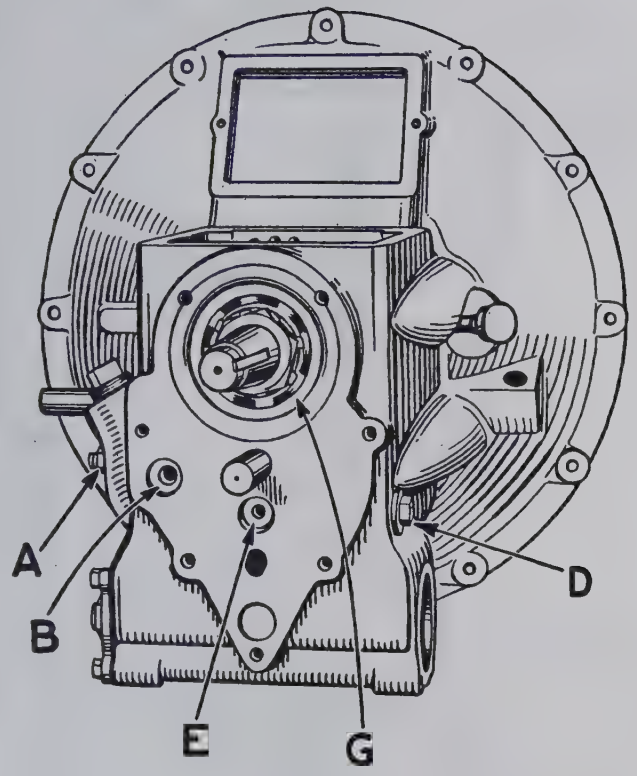
Gear Shift Base—Disassembled



Illus. No. 9
Rear End of Transmission with Parking Brake Removed
(Mechanical Brakes)

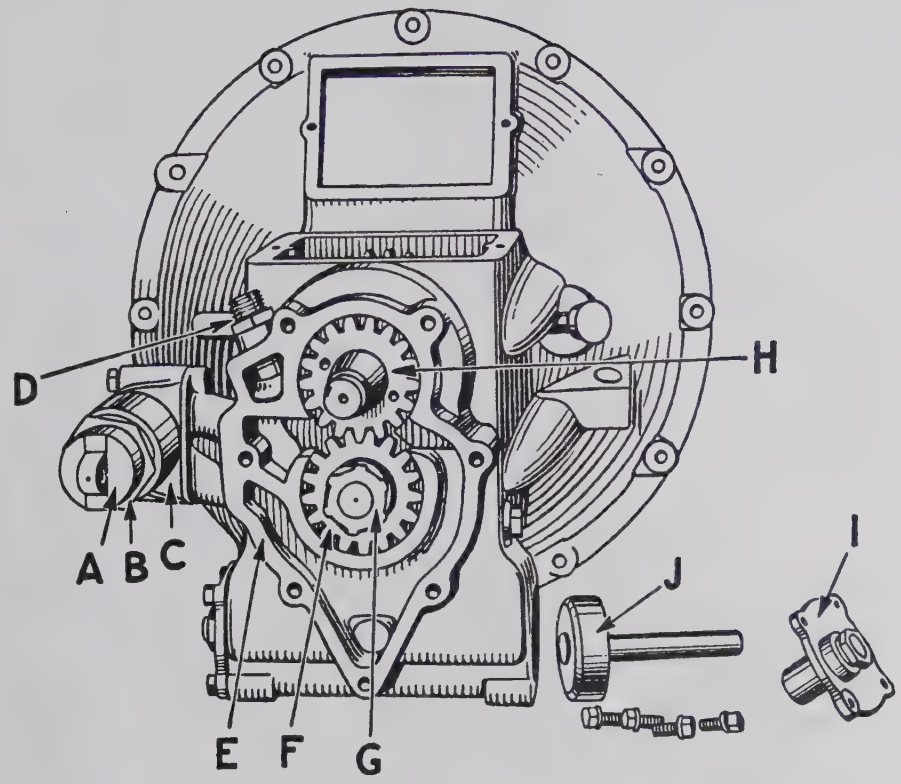


Illus. No. 10
Rear End of Transmission with Parking Brake Removed
(Hydraulic Brakes)



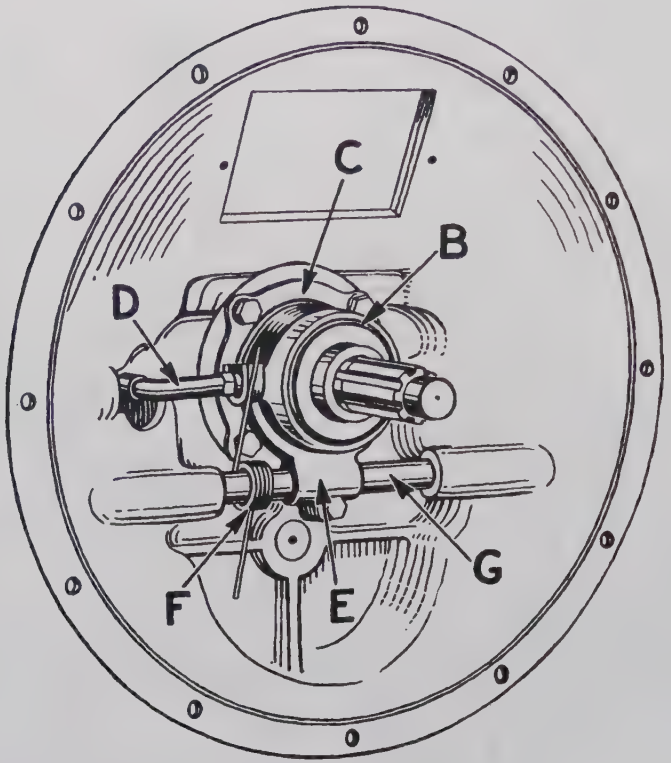
Illus. No. 12

Rear End of Transmission with Service Brake Pump Removed (Hydraulic Brakes)

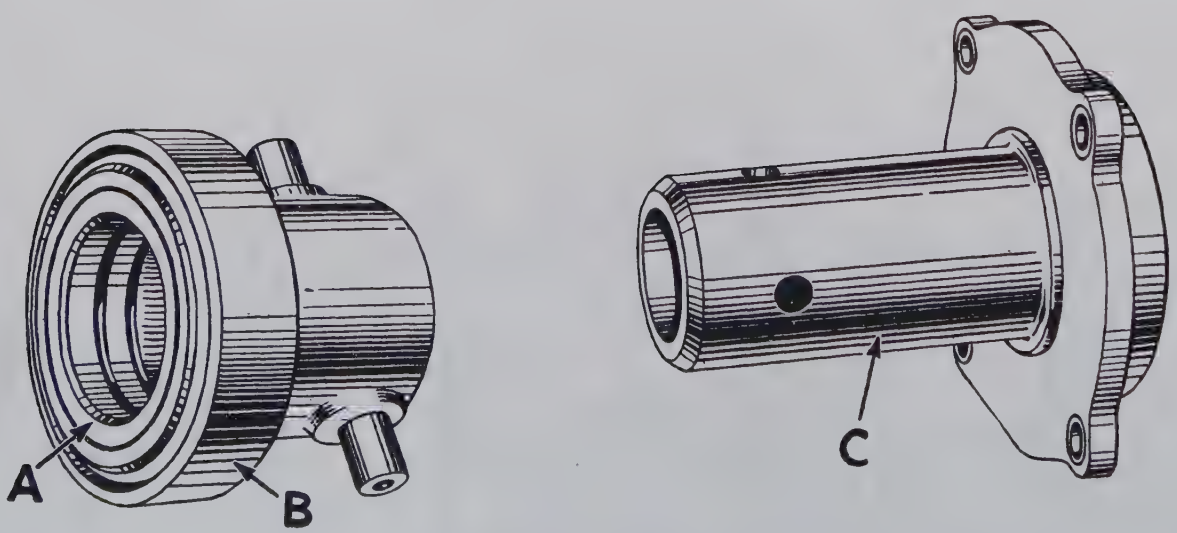


Illus. No. 11

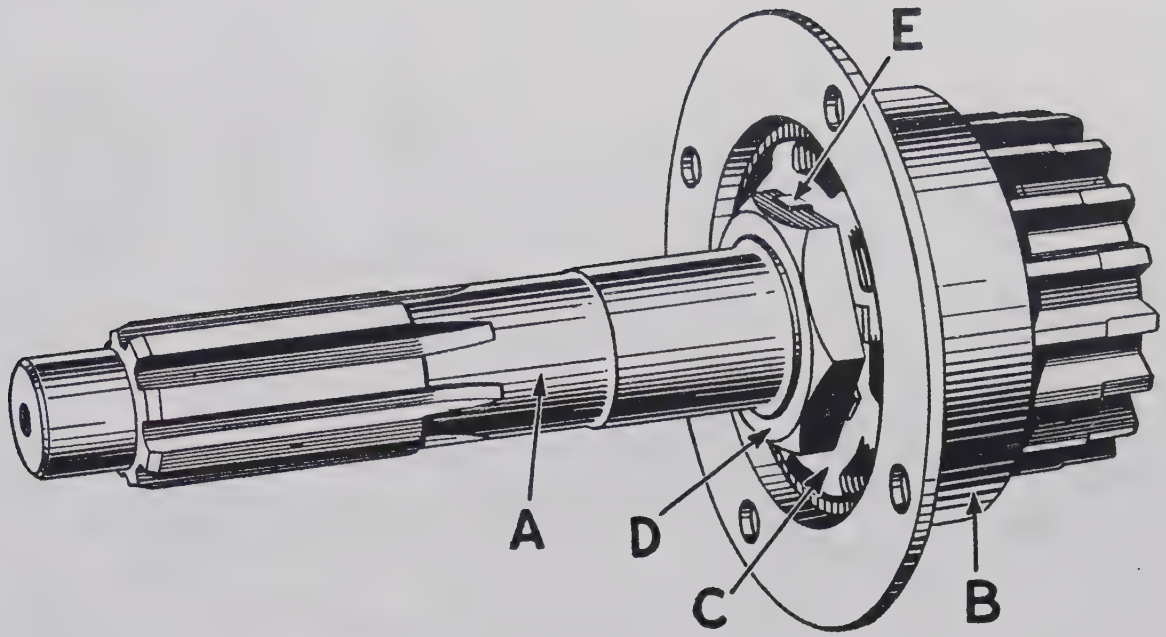
Rear End of Transmission with Service Brake Pump Cover Removed (Hydraulic Brakes)



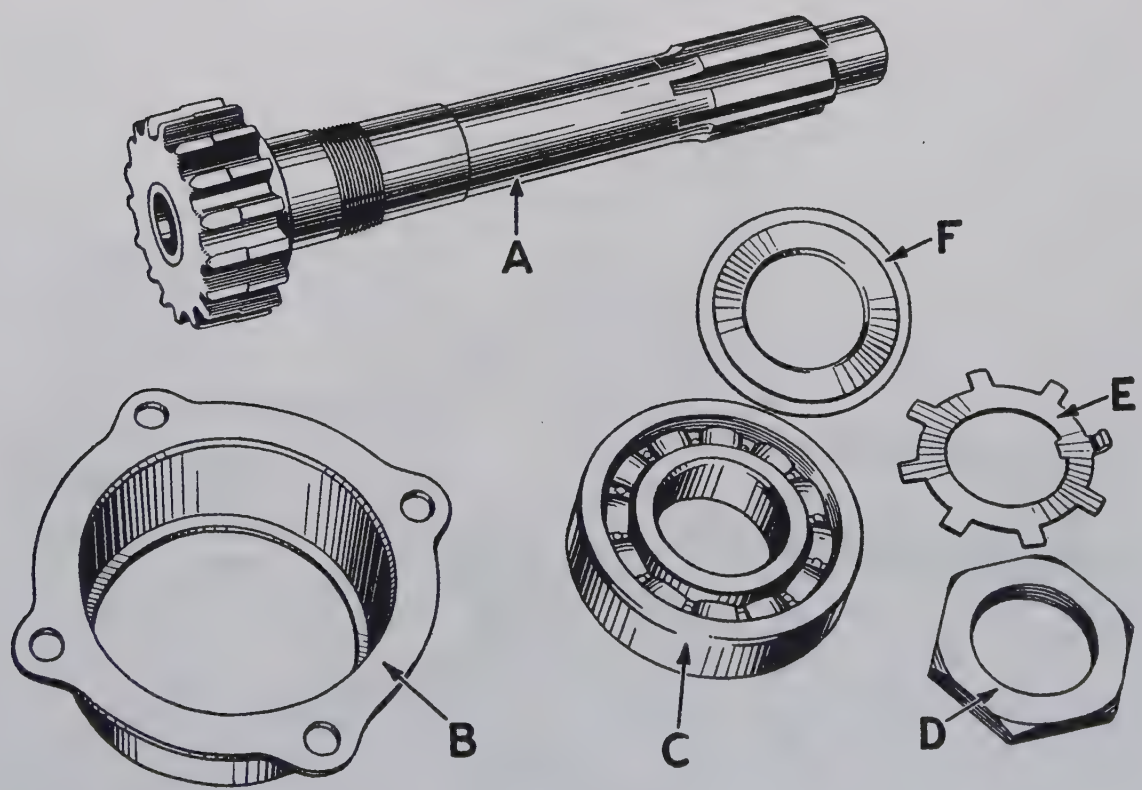
Illus. No. 13
Front End of Transmission Showing Clutch Shifter Shaft and Shifter Bearing



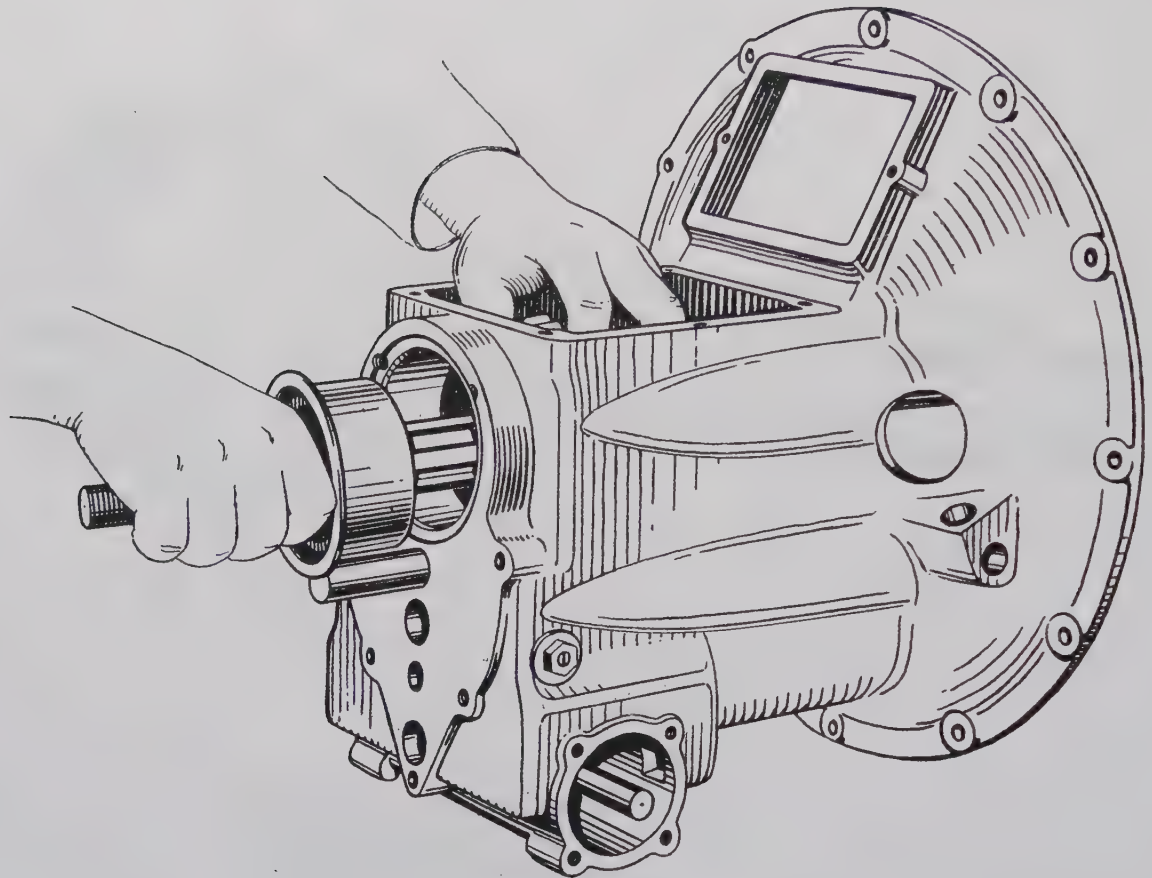
Illus. No. 14
Clutch Shifter Bearing and Transmission Case Front Flange



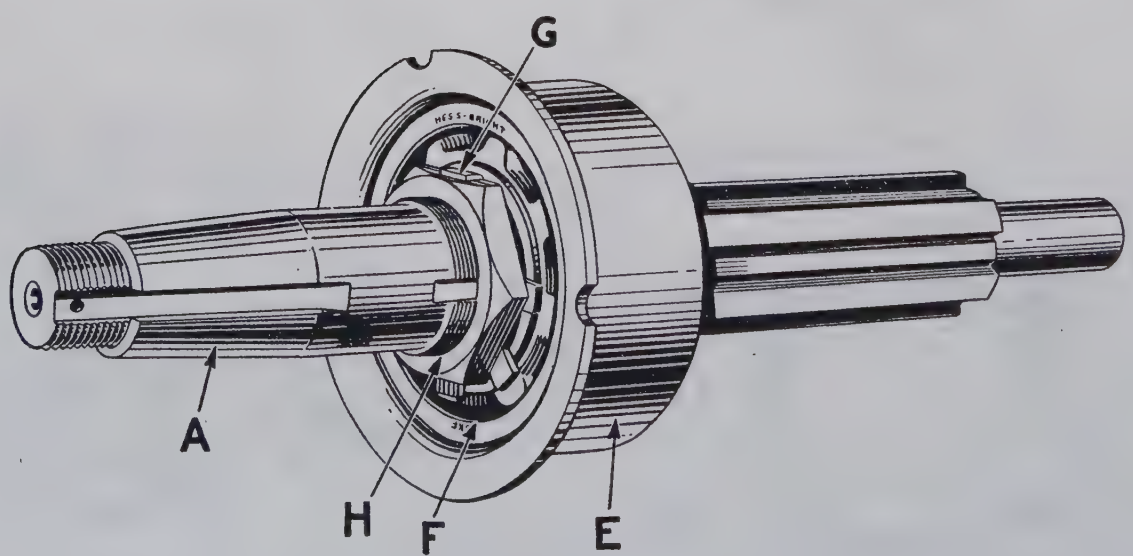
Illus. No. 15
Transmission Pinion Assembly



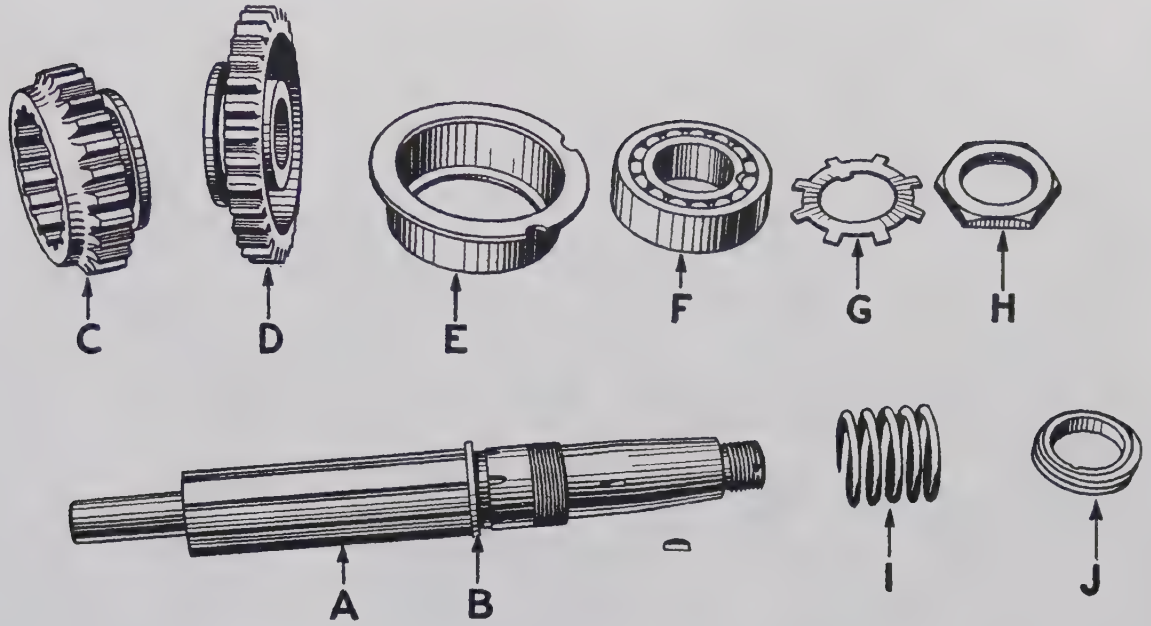
Illus. No. 16
Transmission Pinion—Disassembled



Illus. No. 17
Removing Transmission Shaft Assembly

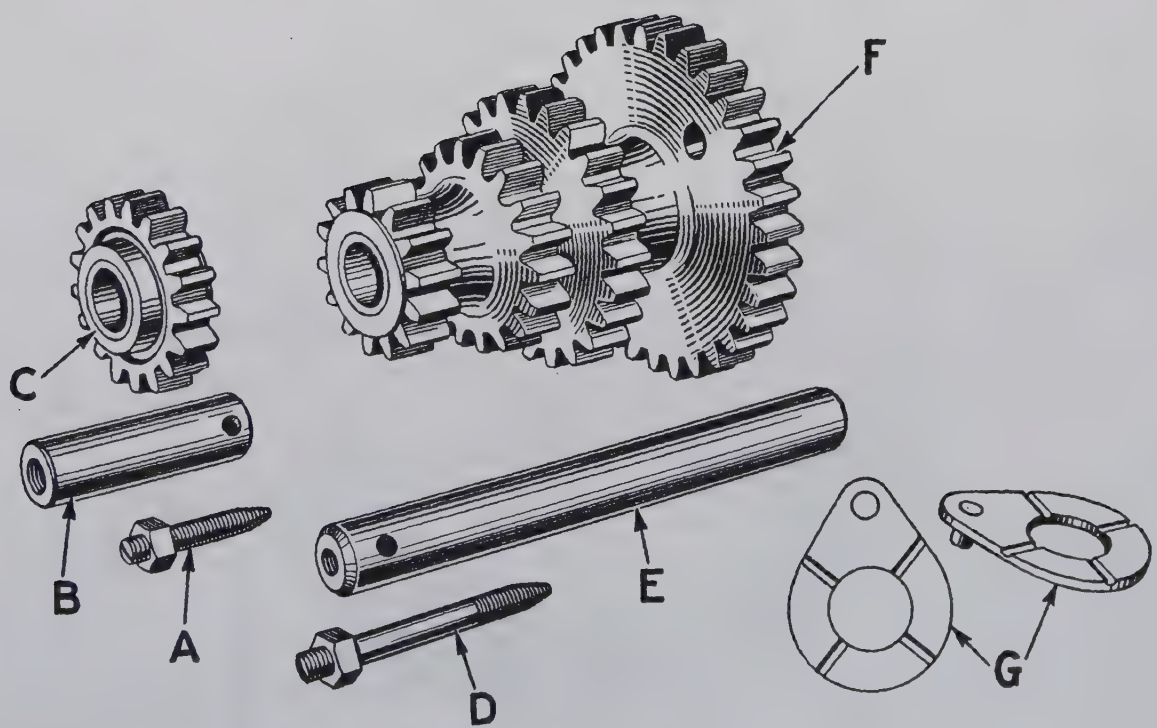


Illus. No. 18
Transmission Shaft Assembly



Illus. No. 19

Transmission Shaft—Disassembled

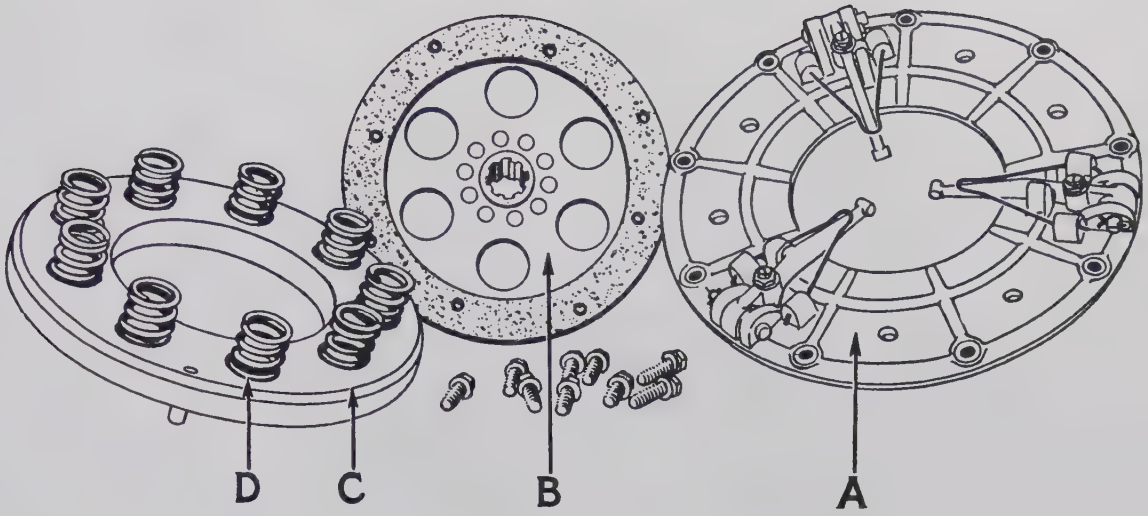


Illus. No. 20

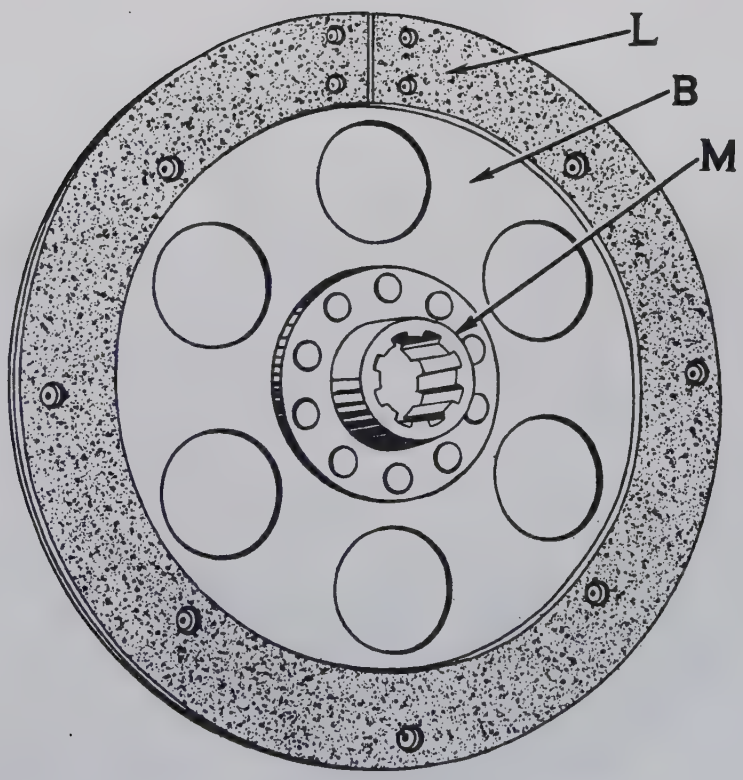
Countershaft Gears and Reverse Idler Gear

Illus. No. 22
Clutch Assembled in Engine

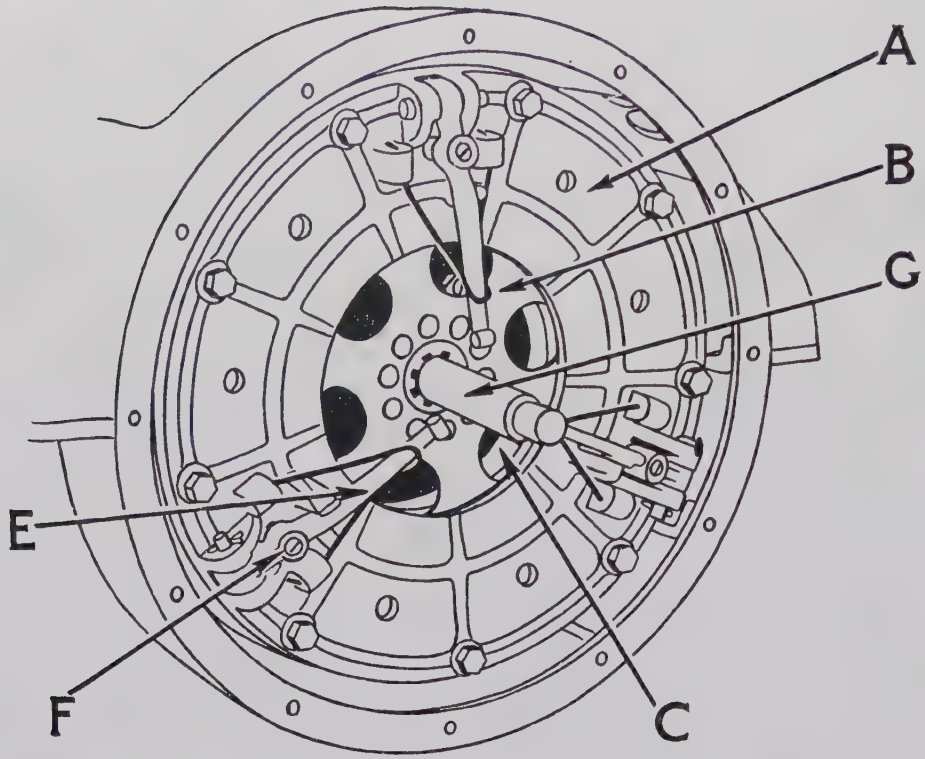
Illus. No. 21
Cross Section of Clutch



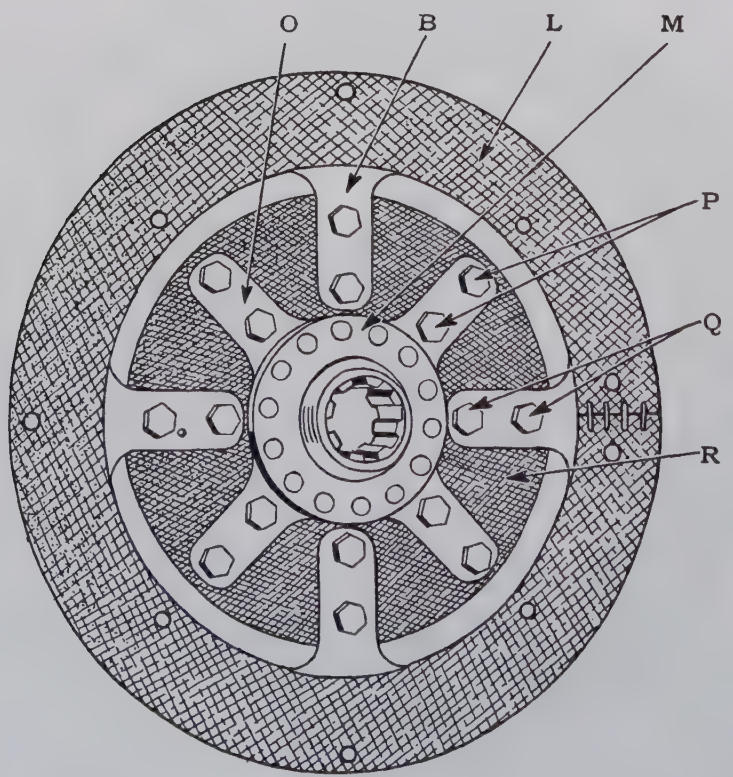
Illus. No. 23
Clutch Disassembled



Illus. No. 24
Clutch Driving Flange with Hub and Discs



Illus. No. 25
Clutch Assembled in Engine and Showing Use of Clutch Driving Flange Aligning Arbor



Illus. No. 26
Clutch Driving Flange with Thermoid Hub Disc

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Insert in Volume Six, Big Six Section, after page 38.
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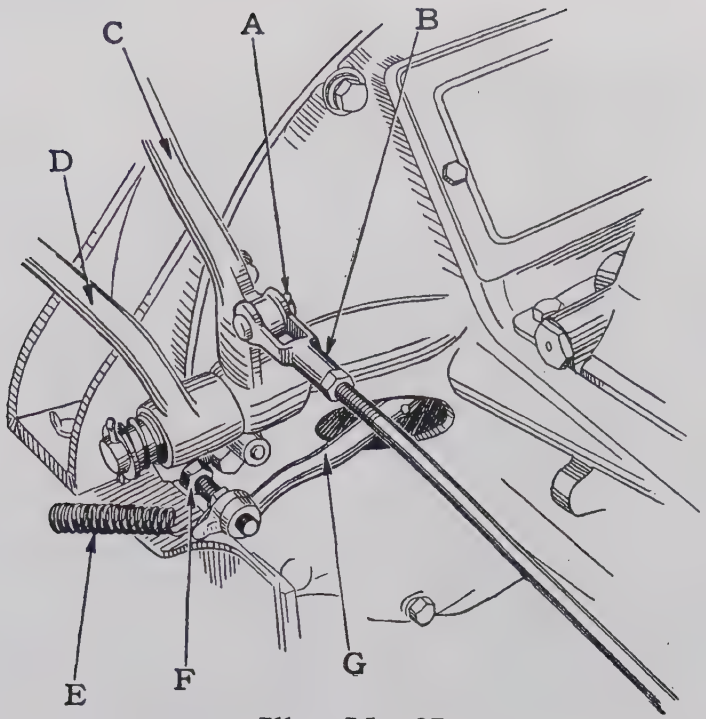
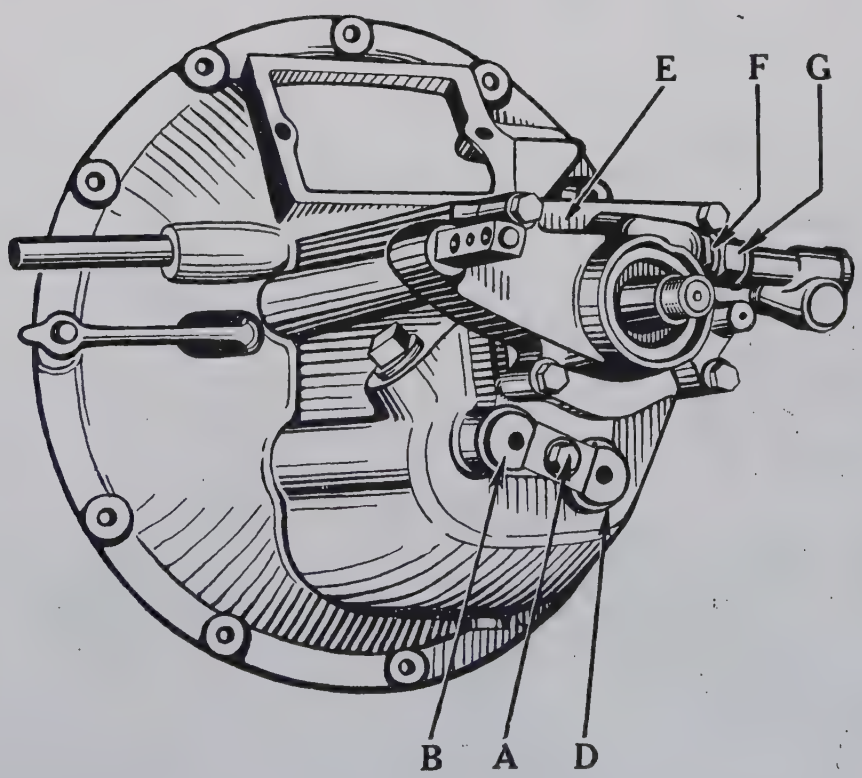
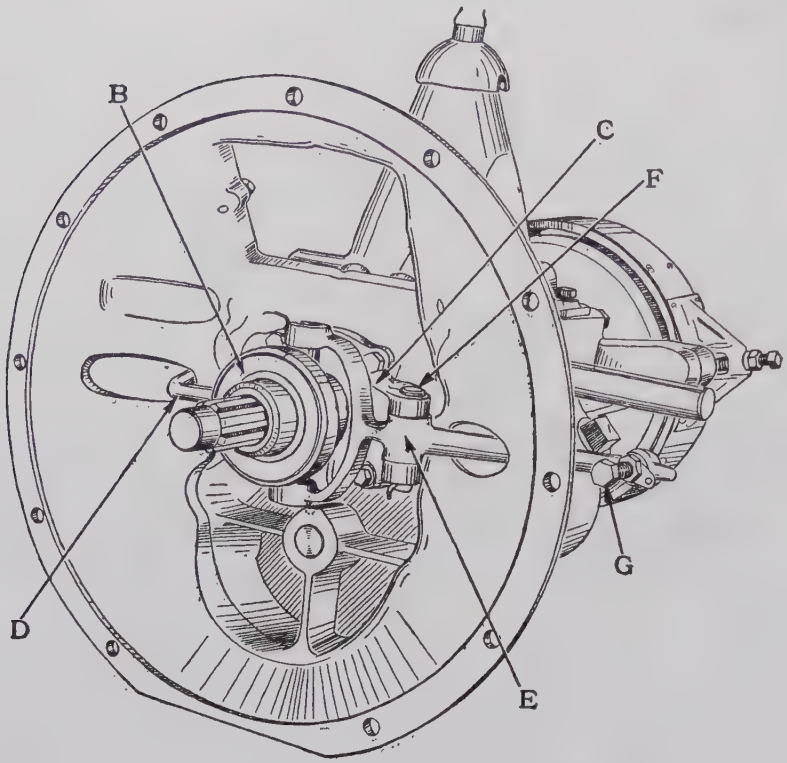


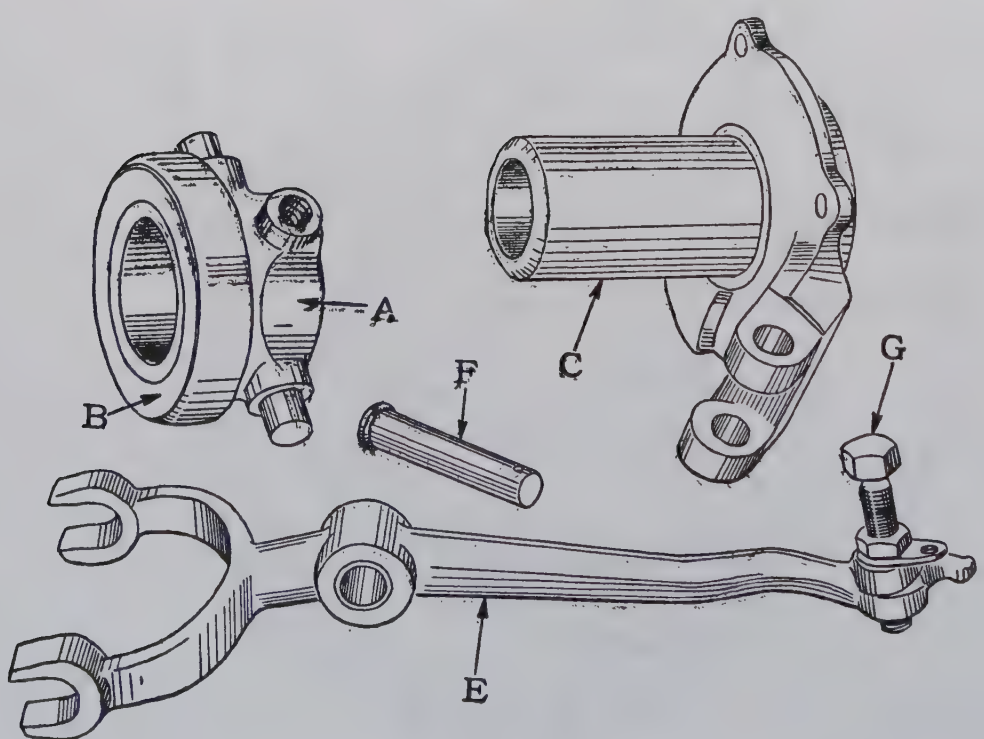
Illus. No. 27
Clutch and Brake Pedal Adjustments
(Long Clutch—Mechanical 4-Wheel Brakes)



Illus. No. 28
Rear End of Transmission with Parking Brake Removed
(Mechanical Brakes)



Illus. No. 29
Front End of Transmission Showing Clutch Shifter Shaft and Shifter Bearing



Illus. No. 30
Clutch Shifter Bearing, Shifter Arm and Transmission Case Front Flange

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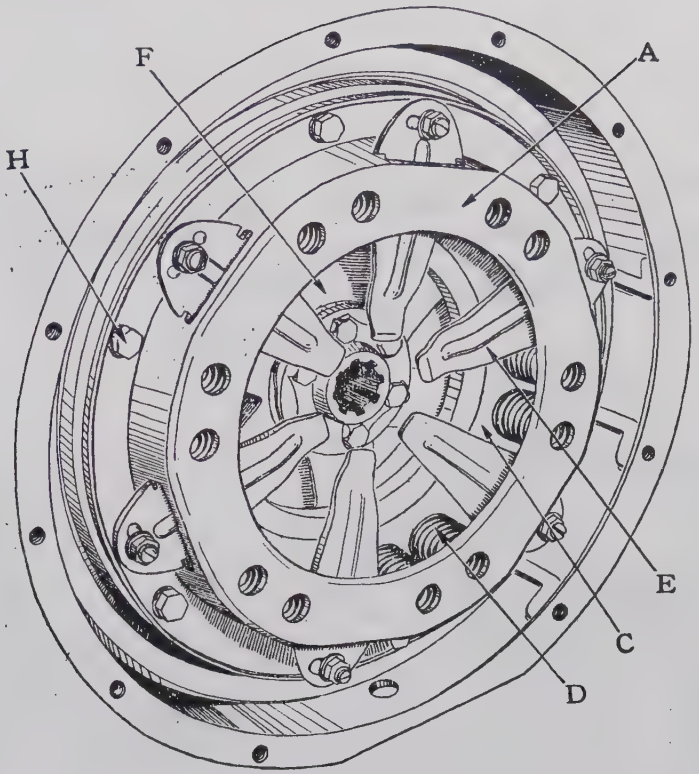
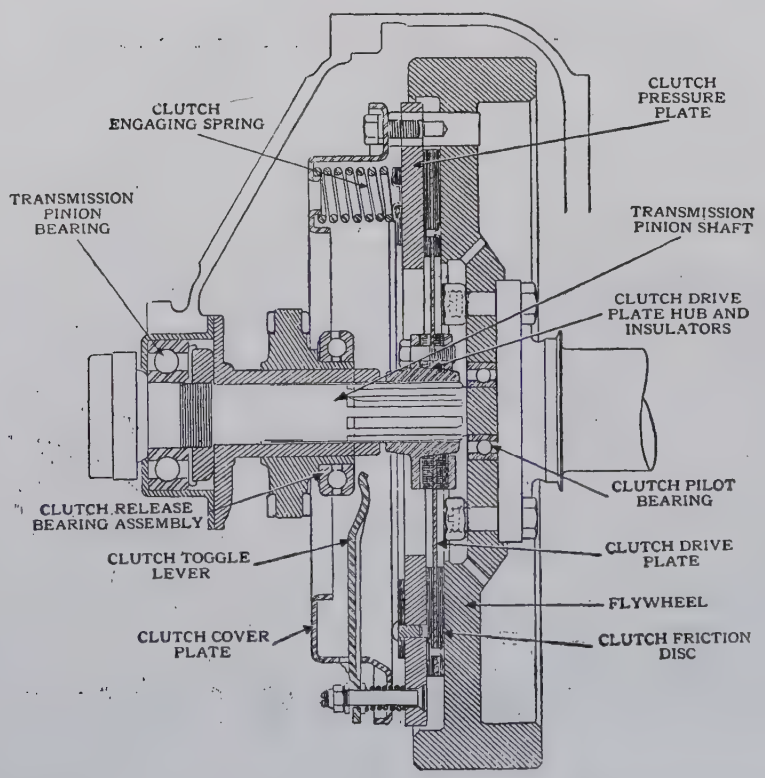
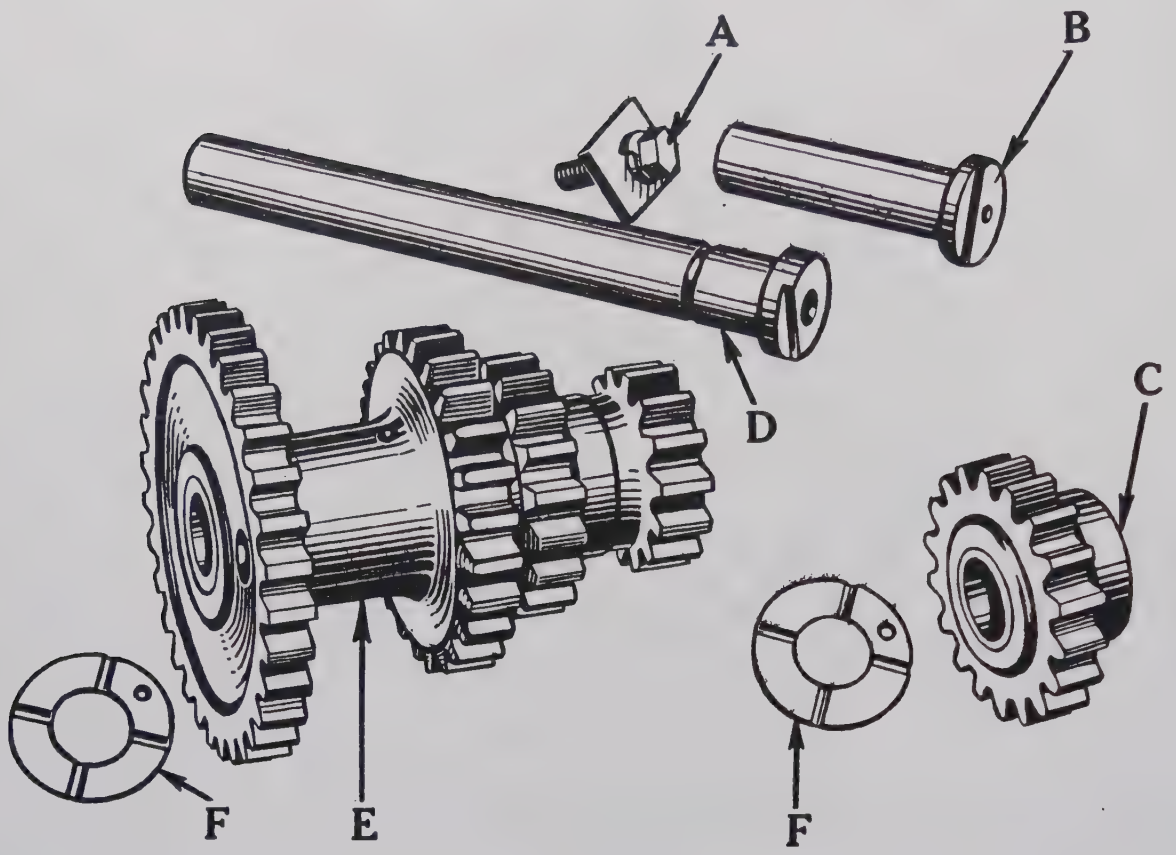


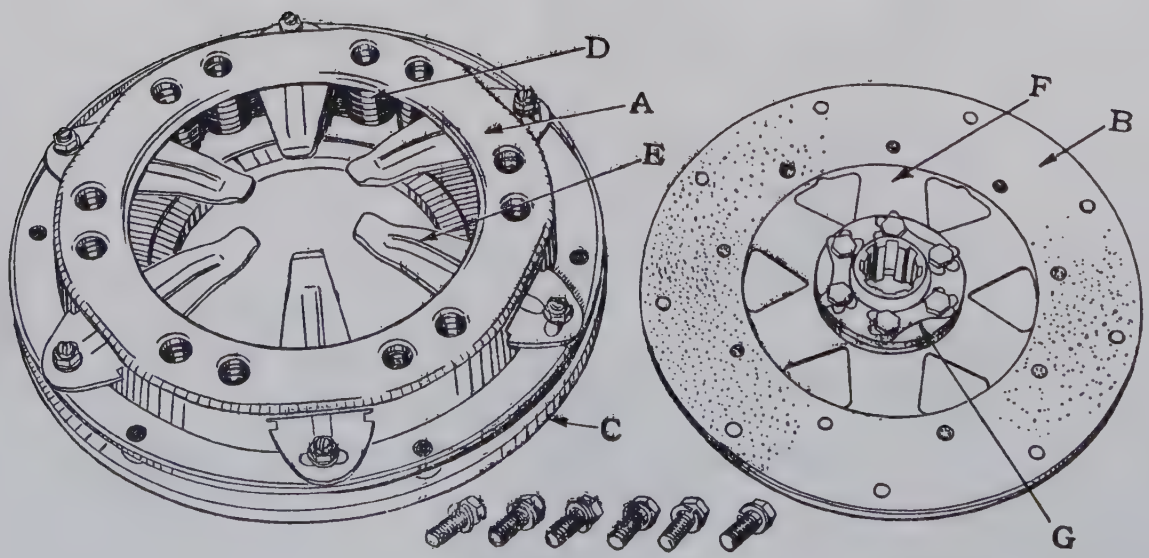
Illus. No. 31
Clutch Assembled in Engine
(Long Clutch)



Illus. No. 32
Cross Section of Long Clutch



Illus. No. 33
Countershaft Gears and Reverse Idler Gear



Illus. No. 34
Clutch Disassembled
(Long Clutch)

OPERATION ARTICLES

The following section is one containing instructions for disassembling, assembling and repairing various units. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised operation article will be carried at the bottom of the green sheet.

For example, the reader is interested in Operation Article No. 3, To Remove and Replace Gear Shift Forks and Rods. Before he reads this, a glance at the bottom of the page will tell whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the Operation Article No. 3, such as 3-1 or 3-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ARTICLE No. 1

To Remove and Replace Gear Shift Base Assembly

1. Unlock and remove the large floor board.
2. Take out the two wood screws and remove the small floor board.
3. Take out the six screws "G" (Illus. No. 4) holding the gear shift base to the transmission case.
4. Lift off the gear shift base assembly.
5. Reverse operations to replace.

Tools Required—Screw driver, ½ inch socket wrench.

ARTICLE No. 2

To Remove and Replace Gear Shift Lever

1. Remove the gear shift base. (See Operation Article No. 1).
2. With a screw driver compress the gear shift lever spring and remove pin "A" (Illus. No. 6).
3. Remove retainer "B" and spring "C".
4. Remove lever "E" and oil washer 'D".
5. Reverse operations to replace.

Tools Required—Screw driver, ½ inch socket wrench, long nosed pliers.

ARTICLE No. 3

To Remove and Replace Gear Shift Rods and Forks

1. Remove the gear shift base. (See Operation Article No. 1).
2. Remove the gear shift lock spring retainers "C" and "L" (Illus. No. 8).
3. Remove springs "D" and "K"; also plungers "E" and 'J".
4. Remove the clamp screws from gear shift forks "B" and "M".
5. The gear shift rods can now be removed one at a time. This will permit removal of the shift forks.
6. Take out interlocking pin "H" which is located in the front end of the base between the gear shift rods.
7. Transmission lock balls "G" can be removed through the gear shift rod holes. (This operation applies only to cars having a transmission lock).
8. Reverse operations to reassemble.

Tools Required—Screw driver ½ inch socket wrench, pliers, hammer, No. 25 and 31 open end wrenches.

ARTICLE No. 4

To Remove and Replace Transmission Assembly

1. Unlock and remove the large floor board.
2. Take out the two wood screws holding the small floor board and remove the board.
3. Disconnect the accelerator. In case of the ball type, disconnect the accelerator rod under the toe board. If the car is equipped with the plunger type, loosen the plunger locking nut under the toe board and unscrew the plunger from the accelerator rod.
4. Take out the screws holding the toe plate in the upper left hand corner of the toe board and remove the plate.
5. Remove the two large screws at the side of the toe board. If the car being worked on has the metal covered toe board, remove the screws holding the toe board cover to the dash. The toe board can now be removed.
6. Loosen the clamp screw holding the clutch pedal adjusting lever to the shifter shaft and drive off the clutch pedal arm and adjusting lever.

7. Remove the key from the shifter shaft.

8. Remove the brake rod clevis pin "D" (Illus. No. 5). Also remove clevis pin "C" on hydraulic brake equipment.

9. Remove brake pedal arm "B" from the clutch shifter shaft.

10. To remove the clutch and brake pedals on passenger cars having four-wheel mechanical brakes, disconnect the brake rod from the brake pedal arm. Remove the cotter pin from the pedal shaft. Both pedals can now be removed.

11. Remove clevis pin "E" from the brake operating lever on each side of the transmission on hydraulic brake equipment only.

12. If working on a passenger car: Take out the six bolts at the real universal joint. Unscrew the brass nut at the front end of the propeller shaft and remove the assembly by sliding the shaft out of the splines at the front end.

13. If working on a bus: Remove the front propeller shaft. See Operation Article No. 56, operations 1 to 3, Vol. 1, or use the following operations:

A—Remove the six universal joint nuts at each end of the propeller shaft and drive out the bolts.

B—Move the rear propeller shaft front universal back on the splines and allow it to drop down.

C—Remove the four U-bolt nuts holding the bearing bracket to the frame cross member and remove the propeller shaft assembly.

14. Remove the clevis pin at "H" (Illus. No. 5), disconnecting the parking brake cable.

15. Unscrew the speedometer cable at "I" (Illus. No. 5).

16. Disconnect the service brake pump pressure gauge pipe at "J" (Illus. No. 5) on hydraulic brake equipment only.

17. Unscrew the six screws "G" and remove the gear shift base assembly.

18. Remove the screws "M" holding the transmission to the flywheel housing. Take great care in this operation to support the transmission so that the transmission pinion shaft will not be sprung.

19. The transmission can now be removed, carefully pulling it out, and turning it slightly to the right to clear the pedal shafts at the cross member, until the transmission pinion shaft is disengaged from the clutch driving flange, then lifting it up to clear the frame cross member and lowering it to the floor.

20. Jack up one of the rear wheels to permit removing the transmission under the running board.

21. Reverse operations to replace.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack.

ARTICLE No. 5

To Remove and Replace Clutch Shifter Bearing

1. Remove the transmission assembly. (See Operation Article No. 4).

2. Unscrew the clutch shifter bearing grease cup.

3. Unscrew extension elbow "D" (Illus. No. 13).

4. Remove the upper end of spring "F", (Illus. No. 13) from the groove in shifter fork "E".

5. Shifter bearing "B" (Illus. No. 13 and 14) can now be pulled off.

6. If it is necessary to remove bearing "A" (Illus. No. 14) from housing "B" this can be driven out with a punch through the small holes in the shoulder of the housing.

7. Reverse operations to replace.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack.

ARTICLE No. 6

To Remove and Replace Clutch Shifter Shaft

1. Remove the transmission assembly. (See Operation Article No. 4).

2. Unscrew the clutch shifter bearing grease cup.

ARTICLE No. 6-1

To Remove and Replace the Clutch Shifter Arm

The following revision in Article No. 6 applies to Big Six cars having the Long Clutch.

1. Remove the transmission assembly. (See Operation Article No. 4).
2. Unscrew the clutch shifter bearing grease cup.
3. The shifter bearing "B" (Illus. No. 29) will now slide forward off the transmission pinion shaft.
4. Remove the cotter pin and the clevis pin "F" from the clutch shifter arm bracket "C".
5. The shifter arm "E" can now be removed.
6. Reverse operations to assemble.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch and jack.

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3. Unscrew extension elbow "D". (Illus. No. 13).

4. Remove the upper end of spring "F" (Illus. No. 13) from the grooves in the shifter fork.

5. Loosen the clamp screw in shifter fork "E".

6. Drive shifter shaft "G" out of fork "E" far enough to expose the Woodruff key holding the fork.

7. Remove the key.

8. The shaft can now be driven the rest of the way out and spring "F" and fork "E" removed.

9. Reverse operations to assemble.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack.

ARTICLE No. 7

To Remove and Replace Transmission Pinion and Bearing Assembly

1. Remove the clutch shifter shaft. (See Operation Article No. 6).

2. Pull off shifter bearing "B" (Illus. No. 13).

3. Remove the four screws holding flange "C" (Illus. No. 13 and 14) and remove the flange.

4. The transmission pinion and bearing assembly can now be removed as in Illus. No. 15.

5. Reverse operations to replace.

When replacing the pinion and flange see that they are properly placed in position so that the oil return hole in the transmission case is free and clear.

Coat both flange gaskets with white lead to insure against leaks.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack.

ARTICLE No. 8

To Disassemble and Assemble Transmission Pinion and Bearings

1. Remove the transmission pinion and bearing assembly. (See Operation Article No. 7).

2. Straighten the lips of lock washer "E" (Illus. No. 15 and 16).

3. Unscrew nut "D" and remove lock washer "E".

4. Bearing "C", retainer "B" and oil ring "F" can be removed by tapping the pinion shaft on a block of wood.

5. Reverse operations to replace.

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack.

ARTICLE No. 9

To Remove and Replace Transmission Shaft and Bearing Assembly
(Mechanical Brake Equipment)

1. Remove the gear shift base assembly. (See Operation Article No. 1).

2. If working on a passenger car: Take out the six bolts at the rear universal joint. Unscrew the brass nuts at the front end of the propeller shaft and remove the assembly by sliding the shaft out of splines at the front end.

3. If working on a bus: Remove the front propeller shaft. (See Operation Article No. 56, operations 1 to 3, Vol. 1 or use the following operations:)

A—Remove the six universal joint nuts at each end of the propeller shaft and drive out the bolts.

B—Move the rear propeller shaft front universal back on the splines and allow it to drop down.

C—Remove the four U bolt nuts holding

the bearing bracket to the frame cross member and remove the propeller shaft assembly.

4. Remove clevis pin "H" (Illus. No. 5).

5. Remove screw "B" (Illus. No. 7) from parking brake release bracket.

6. Remove nut "C" (Illus. No. 7) and take off the brake band assembly. Take care not to lose the two small coil springs at the release bracket.

7. Remove the cotter pin and unscrew nut "A" (Illus. No. 7).

8. The transmission shaft flange can be removed with Universal Puller C.O. 71. (See Vol. 9). The brake drum will be removed with the flange.

9. Unscrew the speedometer cable at "G" (Illus. No. 9).

10. Unscrew nut "F" (Illus. No. 9) and remove the speedometer pinion.

11. Remove the four screws holding parking brake bracket "E" (Illus. No. 9) to the transmission case and remove the bracket.

12. Pull out the transmission shaft and bearing assembly as shown in Illus. No. 17. Remove the two sliding gears through the top of the transmission case.

13. Reverse operations to replace.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, Universal Puller C.O. 71, hammer.

ARTICLE No. 10

To Remove and Replace Transmission Shaft and Bearing Assembly

(Hydraulic Brake Equipment)

1. Remove the gear shift base assembly. (See Operation Article No. 1).

2. Remove the propeller shaft. If working on a passenger car, take out the six bolts at the real universal joint. Unscrew the brass nut at the front end of the propeller shaft and remove the assembly by sliding the shaft out of the splines at the front end.

If working on a bus, see operation No. 3, Operation Article No. 9.

3. Disassemble the service brake pump. (See Operation Article No. 31, Vol. 2, or use the following operations:)

A—Remove the clevis pin at "H" (Illus. No. 5) disconnecting the parking brake cable.

B—Remove screw "B" (Illus. No. 7) from the parking brake release bracket.

C—Remove the two screws holding the brake band adjusting link spring bracket to the pump cover and take off the brake band assembly. Take care not to lose the two small coil springs at "B" (Illus. No. 7).

D—Remove the cotter pin and unscrew nut "A" (Illus No. 7).

E—The transmission shaft flange can be removed with Universal Puller C.O. 71. (See Vol. 8). The brake drum will be removed with the flange.

F—Disconnect the speedometer cable at "I" (Illus. No. 5).

G—Disconnect the pump pressure gauge pipe at the pump.

H—Disconnect the pump operating valve rod from the valve.

I—Remove nut "C" (Illus. No. 10) and take out the speedometer pinion.

J—Remove the seven screws "B" and take off the pump cover.

K—Remove the speedometer drive gear "G" (Illus. No. 11).

L—Pull off the pump drive gear "H" with Universal Puller C.O. 71. (See Vol. 8).

M—Remove the pump driven gear "F".

N—The pump housing "E" can now be removed.

4. Pull out the transmission shaft and bearing assembly as shown in Illus. No. 17. Remove the two sliding gears through the top of the transmission case.

5. Reverse operations to replace, making sure that the pump gaskets are in good condition and see that the body and cover gaskets are not obstructing any oil passages.

In rebuilding the pump, assemble the parts as far as the transmission shaft flange, leaving off

the parking brake and drum. Draw the cover screws just tight enough to hold the cover in position. Rotate the transmission shaft to determine if the pump gears are free. If a binding action is noted, tap the cover and housing slightly until such a position is reached that the transmission shaft turns freely. Then tighten the cover screws before removing the transmission flange to replace the brake drum.

Make sure that the cover screw "B" (Illus. No. 10) is the one with a pilot on the end. This pilot acts as a stop for the pump pistons.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, universal puller C.O. 71, hammer.

ARTICLE No. 11

To Disassemble and Assemble Transmission Shaft and Bearing

1. Remove the transmission shaft and bearing assembly. (See Operation Article No. 9 or 10).
2. On mechanical brake equipment, pull off speedometer drive gear "J" (Illus. No. 19) and remove key and spring "I".
3. Straighten lips of lock washer "G" (Illus. No. 18).
4. Unscrew nut "H" (Illus. No. 18 and 19) and remove nut and lockwasher "G".
5. Press bearing "F" and retainer "E" off of shaft "A" using an arbor press if possible.
6. Remove split ring "B" (Illus. No. 19).
7. The bearing can be removed from the retainer by tapping the retainer on a block of wood.
8. Reverse operations to assemble.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, universal puller, hammer, punch.

ARTICLE No. 12

To Remove and Replace Transmission Reverse Idler Gear

1. Remove the transmission shaft and bearing assembly. (See Operation Article No. 9 or 10).
2. Loosen the lock nut and unscrew the reverse idler gear shaft set screw "A" (Illus. No. 12).
3. Pull reverse idler gear shaft "B" as described under C. O. 403, Vol. 8.
4. Reverse idler gear can now be removed. (See Illus. No. 20).
5. Reverse operations to replace.

Be sure to put the gear in place with the chamfered side of the teeth to the front.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, universal puller, hammer, transmission counter shaft and reverse idler gear shaft puller.

ARTICLE No. 13

To Remove and Replace Counter Shaft Gears

1. Remove the transmission pinion and bearing assembly. (See Operation Article No. 7).
2. Remove the reverse idler gear. (See Operation Article No. 12).
3. Loosen the lock nut and unscrew countershaft set screw "D" (Illus. No. 9) on mechanical brake equipment or "D" (Illus. No. 12) on hydraulic brake equipment.
4. Pull the countershaft as described under C. O. 403, Vol. 8.
5. Countershaft gears "F" (Illus. No. 20) and thrust washers "G" can now be removed.

Tools Required—No. 23, 27 and 31 open end wrenches, adjustable wrench, pliers, 1/2, 9/16 and 1 7/16 inch socket wrenches, screw driver, hammer, punch, jack, universal puller, transmission countershaft and reverse idler gear shaft puller.

ARTICLE No. 14

To Assemble Transmission Complete

(Mechanical Brake Equipment)

1. Place the countershaft gears "F" (Illus. No. 20) in position and slide the countershaft "E" into place making sure that the thrust washers "G" are in place with the grooved side toward the gears.

2. Screw in the countershaft locking screw "D" (Illus. No. 20) and tighten the lock nut.

3. Place the idler gear "C" (Illus. No. 20) in position with the camfered side of the teeth to the front of the transmission and slide the idler gear shaft "B" into place.

4. Screw in the idler gear shaft locking screw "A" (Illus. No. 20) and tighten the lock nut.

See that both front flange gaskets are in good condition and are given a coat of white lead to insure against leaks.

5. Slide the pinion and bearing assembly (Illus. No. 15) into the front of the case making sure that the flange is properly lined up with the oil return hole in the transmission case. Then screw in the four flange bolts.

6. Place the transmission shaft and bearing assembly (Illus. No. 18) in the transmission case but do not enter the shaft in the pinion pilot bushing.

7. Place the large sliding gear (low and reverse) into position on the shaft with the flanged side of the gear hub towards the front of the transmission.

8. Place the small sliding gear (high and intermediate) into position on the shaft with the flange side of the gear hub towards the rear of the transmission.

9. Place the front end of the transmission shaft in the pinion bushing (Illus. No. 16) and slide the shaft into place.

10. Place spring "I" (Illus. No. 19) and the speedometer worm gear "J" on the transmission shaft.

11. Apply the parking brake bracket to the transmission case and screw in the four cap screws.

12. The transmission shaft flange and brake drum can now be placed on the shaft. Screw on the nut and tighten with a heavy socket wrench. Insert the cotter pin.

13. Slide the parking brake band over the drum making sure that the two small springs are in place in the release bracket at "B" (Illus. No. 7).

14. Screw in adjusting screw "B" (Illus. No. 7).

15. Place the adjusting link spring and washer in place and screw on nut "C" (Illus. No. 7).

16. Replace the shifter shaft and bearing. (See Operation Article No. 5 and 6).

17. Replace the transmission assembly in the car. (See Operation Article No. 4).

Fill the transmission to the level of the filler plug with light transmission grease or very heavy transmission oil. In cold weather replace 25 per cent of this with heavy engine oil.

18. Place the gear shift base on the transmission case making sure that both the shift forks are entered into the gear hub flanges. Screw in the six cap screws "G" (Illus. No. 4).

19. Adjust the parking brake band. (See Operation Article No. 37, Vol. 2 or use the following operations:)

A. Turn adjusting screw "B" (Illus. No. 7) until the clearance between the band and the drum is 1/32 of an inch.

B. Turn the lower adjusting nuts "H" (Illus. No. 7) to give the same clearance to the lower half of the band. After making this adjustment be sure to tighten the lower nut against the upper one.

C. Adjust the upper half of the band by means of nut "C" (Illus. No. 7) until 1/32 of an inch clearance is obtained.

Tools Required—Screw driver, pliers, hammer, punch, adjustable wrench, No. 23, 27, 31 and 33 open end wrenches, 1/2, 9/16 and 1 7/16 inch socket wrenches.

ARTICLE No. 13-1

To Remove and Replace Counter Shaft Gears

The following revision in Article No. 13 *applies to Commander cars after serial No.* 4,000,001.

1. Remove the transmission shaft and bearing assembly. (See Operation Article No. 9).
2. Remove the lock screw and plate "A" (Illus. No. 28.)
3. Pull out reverse idler shaft "B".
4. Reverse idler gear "C" can now be removed. (Illus. No. 33.)
5. Pull out counter shaft "D".
6. Counter shaft gears "E" can now be removed.
7. Remove the two counter shaft thrust washers "F".
8. Reverse operations to replace.

Tools Required—No. 25, 27 and 31 open end wrenches, adjustable wrench, pliers, 9/16 and 1 7/16 inch socket wrenches, Universal Puller and a hammer.

Issued October 15, 1927
PRINTED IN U. S. A.

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ARTICLE No. 15

To Assemble Transmission Complete

(Hydraulic Brake Equipment)

1. Place the countershaft gears "F" (Illus. No. 20) in position and slide the countershaft "E" into place making sure that the thrust washers "G" are in place with the grooved side toward the gears.

2. Screw in the countershaft locking screw "D" (Illus. No. 20) and tighten the lock nut.

3. Place the idler gear "C" (Illus. No. 20) in position with the chamfered side of the teeth to the front of the transmission and slide the idler gear shaft "B" into place.

4. Screw in the idler gear shaft locking screw "A" (Illus. No. 20) and tighten the lock nut.

5. Slide the pinion and bearing assembly (Illus. No. 15) into the front of the case making sure that the flange is properly lined with the oil return hole in the transmission case. Then screw in the four flange bolts.

6. Place the transmission shaft and bearing assembly (Illus. No. 18) in the transmission case but do not enter the shaft in the front bushing.

7. Place the large sliding gear (low and reverse) into position on the shaft with the flanged side of the gear hub towards the front of the transmission.

8. Place the small sliding gear (high and intermediate) into position on the shaft with the flanged side of the gear towards the rear of the transmission.

9. Place the front end of the transmission shaft in the pinion bushing (Illus. No. 16) and slide the shaft into place.

10. Apply the brake pump housing "E" (Illus. No. 11) to the transmission case making sure the gasket is in good condition.

11. Slide the brake pump gear "F" and speedometer drive gear "G" on the idler gear shaft (Illus. No. 11). Make sure the speedometer gear lugs are properly meshed in the driven gear.

12. Place the brake pump gear on the transmission shaft and line the key way with the Woodruff key in the shaft. Drive the gear on gently with a brass drift and hammer.

13. Inspect the brake pump cover gasket to see that it is in serviceable condition.

14. Apply the cover to the pump and insert the seven screws. Draw the cover screws just tight enough to hold the cover in position.

15. Slide the flange onto the transmission shaft, leaving off the parking brake drum and flange nut.

16. Rotate the transmission shaft to determine if the pump gears are free. If a binding action is noted, tap the cover and housing slightly until such a position is reached that the transmission shaft turns freely. Then tighten the cover screws before removing the transmission flange to replace the brake drum.

Make sure that cover screw "B" (Illus. No. 10) is the one with a pilot on the end. This pilot acts as a stop for the pump pistons.

17. Replace the transmission shaft flange and parking brake drum. Tighten the flange nut with a heavy socket wrench and insert the cotter pin.

18. Slide the parking brake band over the drum making sure that the two small springs are in place in release bracket at "B" (Illus. No. 7).

19. Screw in adjusting screw "B" (Illus. No. 7).

20. Place the adjusting link spring and washer in place and screw on nut "C" (Illus. No. 7).

21. Replace the shifter shaft and bearing. (See Operation Article No. 5 and 6).

22. Replace the transmission assembly in the car. (See Operation Article No. 4).

Fill the transmission to the level of the filler plug with medium engine oil. In cold weather use a light, *cold test* engine oil.

23. Place the gear shift base on the transmission case making sure that both shift forks are entered into the gear hub flanges. Screw in the six cap screws "G" (Illus. No. 5).

24. Adjust parking brake band. (See Operation Article No. 37, Vol. 2, or use the following operations:)

A. Turn adjusting screw "B" (Illus. No. 7) until the clearance between the band and drum is 1/32 of an inch.

B. Turn the lower adjusting nuts at "H" (Illus. No. 7) to give the same clearance to the lower half of the band.

After making this adjustment be sure to tighten the lower nut against the upper one.

C. Adjust the upper half of the band by means of nut "C" (Illus. No. 7) until 1/32 of an inch clearance is obtained.

Tools Required—Screw driver, pliers, hammer, punch, adjustable wrench, No. 23, 27, 31 and 33 open end wrenches, 1/2, 9/16 and 1 7/16 inch socket wrenches, brass drift.

ARTICLE No. 16

To Drain and Flush Out Transmission

1. Remove the gear shift base assembly. (See Operation Article No. 1).
2. Remove the drain plug at the bottom of the transmission case and allow all oil to drain out.
3. Wash the inside of the case and all parts thoroughly with gasoline.
4. Before replacing the drain plug see that all gasoline has drained from the case.
5. Replace the gear shift base assembly.
6. Fill the case to the level of the filler plug with the proper grade of oil.

In the hydraulic brake transmission use a medium engine oil in warm weather and a light, *cold test* oil in cold weather.

In the mechanical brake transmission use a light transmission grease or very heavy transmission oil. In cold weather replace 25 per cent of this with heavy engine oil.

Tools Required—Screw driver, ½ inch socket wrench, adjustable wrench, pail.

ARTICLE No. 17

To Disassemble and Assemble Clutch

1. Remove the transmission assembly. (See Operation Article No. 4).
2. Remove the nine fastening screws "N" (Illus. No. 22) holding outer plate "A" to the flywheel. Turn these screws out gradually so as to equalize the strain on the outer plate.
3. Outer plate "A" (Illus. No. 22 and 23), driving flange "B", inner plate "C", and springs "D" can now be removed in the order named.
4. If necessary to remove the clutch pilot bearing this can now be pulled out.
5. Reverse operations to replace.

Be sure to pack the pilot bearing well with grease before replacing.

When putting the clutch driving flange "B" (Illus. No. 23) into position it must be properly centered so that the flutes in the flange hub will line up with the pilot bearing when replacing the transmission assembly. After replacing the flange, put C.O. 402 clutch driving flange aligning arbor "G" (Illus. No. 25) through the flange hub so that the pilot on the arbor enters the pilot bearing in the crankshaft.

Then replace outer plate "A" (Illus. No. 25) tightening the screws gradually and equally so as not to strain the plate. Be sure that the holes under the three adjusting screws "F" are over the three pins in inner plate "C".

After the outer plate has been tightened this will hold the driving flange in alignment and arbor "G" (Illus. No. 25) may be removed.

For clutch adjustment refer to Operation Article No. 20.

Tools Required—No. 23 and 27 end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack, clutch flange aligning arbor.

ARTICLE No. 18

To Replace Clutch Driving Flange Discs

1. Disassemble the clutch. (See Operation Article No. 17).
2. Drill out the rivets holding the discs to the flange. Do not cut them with a chisel as this

ARTICLE No. 17-1

To Disassemble and Assemble Clutch

The following revision in Article No. 17 *applies to the Big Six cars built with the Long Clutch.*

1. Remove the transmission assembly. (See Operation Article No. 4).

2. Remove the six fastening screws "H" (Illus. No. 31) holding the clutch assembly to the flywheel.

Turn these screws out gradually so as to equalize the strain on the outer plate. The outer plate "A", springs "D" and the inner plate "C" will come out as an assembly.

Note—The above mentioned assembly is assembled, tested and adjusted at the factory and no adjustment of the toggle levers should be attempted.

3. Remove the clutch driving flange "F".

4. If necessary to remove the clutch pilot bearing, this can now be pulled out.

5. Reverse operations to replace.

Be sure to pack the pilot bearing well with grease before replacing.

When putting the clutch driving flange "F" (Illus. No. 34) into position it must be properly centered so that the flutes in the flange hub will line up with the pilot bearing when replacing the transmission assembly. After replacing the flange, put C. O. 402 clutch driving flange aligning arbor "G" (Illus. No. 25) thru the flange hub so that the pilot on the arbor enters the pilot bearing in the crankshaft.

Then replace the outer assembly "A" (Illus. No. 31), tightening the screws gradually and equally so as not to strain the plate.

Remove the aligning arbor "G".

The only adjustment to be made on this type clutch is the pedal adjustment (See Article No. 20-1).

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack and clutch aligning arbor C. O. 402.

Issued October 15, 1927
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PRINTED IN U. S. A.

may distort the flange. Do not drill clear through the rivet. Use a 9/64 inch drill and drill just deep enough to separate the head of the rivet from the shank.

3. Place the two new discs on the flange, making sure that the counterbored side of the holes in the discs are toward the outside.

4. Insert the rivets, one at a time, and head them over, being sure to pull the rivet heads well below the surface.

5. Suspend the flange between the centers on an arbor and test for trueness with an indicator against the side of the flange. If it runs out more than .005 of an inch it must be straightened.

6. Assemble the clutch. (See Operation Article No. 17).

Tools Required—No. 25 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack, clutch flange aligning arbor C.O. 402, 9/64 inch drill, hand drill.

ARTICLE No. 19

To Replace Fabric Disc in Clutch Driving Flange Hub

1. Disassemble the clutch. (See Operation Article No. 17).

2. Remove the sixteen bolts holding the thermoid disc and remove the disc.

3. Install the new disc and tighten the bolts securely. Use new bolts if others are not in first class condition.

4. Peen the ends of the bolts with a chisel and hammer to prevent loosening.

5. Assemble the clutch. (See Operation Article No. 17).

Tools Required—No. 23 and 27 open end wrenches, 1/2 and 9/16 inch socket wrenches, pliers, screw driver, hammer, punch, jack, clutch flange aligning arbor C.O. 402 chisel.

ARTICLE No. 20

To Adjust Clutch

The first eight operations are for use only when adjusting the clutch used previous to the custom models or on the bus chassis.

1. Loosen the clutch pedal arm clamp screw "B" (Illus. No. 21).

2. By means of adjusting screw "C" move the clutch pedal arm so that the clearance between the under side of the pedal pad and toe board is five inches.

Note—If the adjustment brings the pedal arm closer than ⅛ of an inch to the under side of the toe board it is too close and must be readjusted to give this clearance. Then loosen the nuts holding pedal pad "D" in pedal arm "E". Screw the pedal pad in or out until there is five inches clearance between the pad and the toe board.

Be sure to tighten all lock nuts after adjusting.

3. Remove the floor and toe boards. (See Operation Article No. 4, operations 1 to 5 inclusive).

4. Remove the plate over the hand hole in the transmission bell housing.

5. Press the clutch pedal and place Clutch Adjusting Gauge C.O. 407 at point "A" (Illus. No. 21) between the transmission case flange and the clutch shifter bearing housing. Make sure that the C.O. 407 gauge used is 3/16 of an inch thick which supersedes the 1/8 inch gauge of the same number.

6. Loosen the lock nut on one of the toggle lever adjusting screws "H" (Illus. No. 21) and turn the screw in or out until lever "F" is just in contact with the shifter bearing. Then tighten the lock nut.

7. Repeat operation 6 on the other two adjusting screws, one at a time.

8. Remove the clutch adjusting gauge and reverse operations 3 and 4.

Use the following operations when adjusting the clutch on the custom models.

1. Loosen the stop screw lock nut at the lower end of the pedal arm and turn the screw until the clearance between the under side of the pedal pad

and toe board is 5½ inches.

Note—If this adjustment brings the pedal arm closer than ⅛ of an inch to the under side of the toe board, it is too close and should be readjusted to give this clearance. Then loosen the nuts holding the pedal pad in the upper end of the pedal arm and screw the pedal pad in or out until there is 5½ inches clearance between the pad and the toe board. Be sure to tighten the lock nuts after adjusting.

2. Remove the floor and toe boards. See Operation Article No. 4, operation 1 to 5 inclusive.

3. Remove the plate over the hand hole in the transmission bell housing

4. Press the clutch pedal and place clutch adjusting gauge C.O. 407 between the transmission case flange and the clutch shifter bearing housing. Make sure that the C.O. 407 gauge used is 3/16 of an inch thick which supersedes the ⅛ inch gauge of the same number.

5. Loosen the lock nut one one of the toggle lever adjusting screws "H" (Illus. No. 21) and turn the screw in or out until lever "F" is just in contact with the shifter bearing. Then tighten the lock nut.

6. Repeat operation 5 on the other two adjusting screws, one at a time.

7. Remove the clutch adjusting gauge and reverse operations 2 and 3.

Tools Required—No. 25 open end wrench, screw driver, pliers, clutch adjusting gauge C.O. 407.

ARTICLE No. 20-1

To Adjust Clutch Pedal

The following revision in Article No. 20 applies to Big Six cars built with the Long Clutch.

1. Loosen the clutch pedal arm lower stop screw lock nut and adjust the stop screw "F" (Illus. No. 27) so that the pedal pad has one full inch of free movement before the clutch starts to release.

2. Lock the pedal arm stop screw nut.

3. Adjust the pedal pad to have a 6 inch clearance between the toe board and pedal pad. The lower pedal arm spring "E" will hold the pedal arm back to the toe board.

Tools Required—No. 25 and 27 open end wrenches and a pair of pliers.

Issued October 15, 1927
Insert in Volume Six, Big Six Section, after page 50.
PRINTED IN U. S. A.

STUDEBAKER
Service Reference Library

A work of reference for the guidance of Studebaker Dealers

1927 Edition

Published by

General Service Department
THE STUDEBAKER CORPORATION OF AMERICA
South Bend, Indiana

FOREWORD

MOST Studebaker dealers are already familiar with the Studebaker Service Manual which was issued several years ago, so that this latest work needs little introduction. Incorporating information on the line of automobiles announced September 14, 1924, it should immediately take its place in the shop, beside the original book.

We wish to take this opportunity to thank the many Studebaker dealers who were interested enough to contribute their suggestions and ideas.

The new edition has grown to such proportions that the term "Service Manual" seemed inadequate and was therefore changed to "Service Reference Library." It has been separated into a number of different volumes, each volume covering only a portion of the car. Thus it is possible for several men to use it at once—one, for instance, using the volume on engines while others are making use of the book on transmissions or electrical equipment. The separate volumes, being smaller, are easier to handle and easier to keep up-to-date with new sheets.

Everyone in possession of one of these Libraries will be put on our mailing list to receive insert sheets covering new and revised instructions as issued. New instructions will go out on white paper while revisions in the present instructions will be printed on green paper. The use of these sheets is fully explained on page 79.

We invite correspondence from everyone having suggestions that will make the Library more complete and of more value to our service men.

General Service Department,
The Studebaker Corporation of America,
South Bend, Indiana.

Volume Seven

ELECTRICAL EQUIPMENT

ALL MODELS

Unless otherwise specified the information herein given applies to all cars after Big Six serial number 2,060,001, Special Six serial number 3,120,001, Standard Six serial number 1,202,001, Bus Chassis serial numbers 2,070,600 and 3,173,001 and Erskine Six.

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Service Reference Library
In Nine Volumes

Volume One

Front axle, steering gear, rear axle and propeller shaft. All models.

Volume Two

Brakes, chassis, body and miscellaneous. All models.

Volume Three

Big Six, Special Six and Bus chassis engine and gasoline system.

Volume Four

Standard Six engine and gasoline system.

Volume Five

Erskine Six engine and gasoline system.

Volume Six

Transmission and clutch. All models.

Volume Seven

Electrical equipment. All models.

Volume Eight

Service tools.

Volume Nine

Studebaker Service Bulletins.

INTRODUCTORY

This information has been prepared for the purpose of assisting the electrical repair men in readily locating and remedying electrical troubles. It is divided into four sections:

First: An outline discussion of electrical troubles with methods for locating and remedying them.

Second: The description and operation of equipment.

Third: An illustrated section.

Fourth: A series of operation articles detailing the procedure in removing and disassembling the various units.

Section one is introduced with a complete outline which furnishes a method for speedily locating any fault in the equipment. It goes into a detailed description of each fault and describes the symptoms or indications; also test and remedy. This in itself is quite complete.

This volume is prepared, not with the idea of teaching repairmen to become electrical men, but merely to place the necessary information in the hands of those who must look after the work.

Some rather complicated tests and repairs have been described, however, and the operator is cautioned against attempting difficult repairs unless equipped to do the work, for otherwise considerable damage may be done. The services of a competent electrical Service Station are to be recommended in all cases where such are within reach.

ANALYSIS OF TROUBLES

GENERATORS

ARMATURE ..... G1.

SHORTED ARMATURE G1.1

Indication: Armature over-heats—solder melted out of commutator—insulation burned—charging rate low or zero. May be intermittent or "swinging short."

Cause: Wires come in contact with each other due to damaged or defective insulation. May also be due to metal chips between commutator bars.

Test: Connect the generator to the battery with the the ammeter in the circuit. (Omit Relay). (See Illus. No. 20). The generator will run as a motor and the ammeter will indicate the current drawn. If the armature rotates by jerks, and draws a pulsating current, the armature is apparently damaged. Make sure that the armature is free to rotate and that it does not rub the poles or bind in the bearings.

A more accurate test can be made by using a growler. Remove the armature from the generator. Connect the growler to a 110 volt A.C. line and lay the armature between the poles. Hold a saw blade along the armature core, rotating the armature by hand. As the shorted coil passes under the blade it will cause it to vibrate. (See Illus. No. 25).

Remedy: Clean out slots between the commutator bars. If the short between wires is not readily accessible, the armature should be exchanged for a new one.

OPEN ARMATURE G1.2

Indication: Low or zero charging rate—commutator burned at the bars connected to open circuited coils.

Cause: Connection unsoldered at commutator—wire broken.

Test: Test armature as in G1.1, first paragraph.

Remedy: Resolder connection. If damage is not accessible, exchange armature for a new one.

GROUNDED ARMATURE G1.3

Indication: The indication will be the same as a shorted armature. If the generator is ball bearing, the bearings may be pitted due to the current flowing through them.

Cause: Wires come in contact with armature shaft or laminations due to damaged or defective insulation.

Test: Insulate the brushes from the commutator and test between the commutator and shaft with a test lamp. To locate the exact position of the ground, it may be necessary to disconnect the leads from the commutator and test each coil separately. This should be done only by an experienced armature repairman.

Remedy: If the defect is readily accessible, it can be reinsulated, otherwise the armature should be exchanged for a new one.

ARMATURE RUBS OR BINDS G1.4

Indication: Generator noisy—armature cannot be rotated easily.

Cause: Loose pole—worn bearings—bent shaft—improper assembly.

Test: Examine the generator—look for scored places on the armature core.

Remedy: Tighten loose parts. Make sure the heads are properly fastened against the ends of the frame. Replace worn bearings.

COMMUTATOR G1.5

A commutator in good condition will be smooth and free from pits or burned spots. It will be colored a chocolate brown, sometimes having a purplish cast. This coloring will be especially evident over that portion of the commutator on which the brushes bear.

DIRTY OR GREASY COMMUTATOR G1.51

Indication: Generator will not charge until relay contacts are closed by hand.

Cause: Improper brushes—excessive lubrication of the commutator end bearing—cover band left off the generator.

Test: Examine the commutator. The commutator may be covered with a thin film or glaze which is not easily distinguished.

Remedy: Clean the commutator with a rag moistened in gasoline. To polish the commutator use a strip of fine (No. 00) sandpaper. Pass this around the commutator with the sanded side in and draw it back and forth while the armature is rotating.

COMMUTATOR OUT OF ROUND G1.52

Indication: Generator stops charging or charges unsteadily at high speed.

Cause: One or more bars higher or lower than the rest. Commutator may have been turned down by a careless workman.

Test: Rotate the armature slowly and hold a pencil on one of the brushes. If the commutator is out of round, the brush can be felt to rise and fall as the armature rotates.

Remedy: Turn down the commutator in a lathe. Rotate the armature at high speed and take a very light cut with a sharp tool. Do not remove any more material than is necessary to true up the commutator. Polish the commutator with a strip of fine (No. 00) sandpaper. The mica between the bars should now be undercut to a depth of about 1/32 of an inch. This is best accomplished by an undercutting machine but it can be done by using a hacksaw blade that has been ground down until it is only slightly thicker than the mica. This is drawn back and forth along the mica until the latter is undercut to the proper depth.

HIGH MICA G1.53

Indication: Charging rate low or unsteady—arcing and burning of the brushes.

Cause: Copper is softer than mica and so it wears away more readily, leaving the mica.

Test: Examine the commutator closely. The mica should be below the surface of the bars.

Remedy: True up the commutator and undercut the mica as in G1.52.

BEARINGS G2.

The air gap or clearance between the armature and the poles of a generator is only a few thousandths of an inch and so the bearings in which the armature rotates must be accurate to prevent the armature from rubbing the poles. When the bearings have worn an amount equal to the clearance between the armature and poles, the armature will strike the poles. The bearings must also be properly aligned so that the armature will turn freely without binding. For these reasons, care should always be taken in assembling a generator to make sure that the heads are properly fitted to the frame and that the lubricating devices for the bearings are in good condition.

WORN OR DAMAGED BALL BEARINGS G2.1

Indication: Noisy bearings—bearings bind so that the armature does not rotate freely.

Cause: Dirt or grit in the bearing—lack of lubrication—grounded armature.

Test: Examine the bearings.

Remedy: New bearings. If the bearing is merely dirty, it can be cleaned with gasoline or kerosene. When installing or removing ball bearings, do not pound on them. Use a press or a ballbearing puller. Make sure that the bearings are properly aligned so that they will not bind and wear rapidly.

EXCESSIVE END PLAY G2.3

Indication: Noisy generator—may sound like a knock in the engine.

Cause: Wear of thrust washers or bushings. Thrust washers may have to be omitted.

Test: Check the end play—should be .001 to .005 of an inch.

Remedy: Install shims. The ball bearings are shimmed behind either the inner or outer race, depending on the installation. The end play of ball bearing generators is usually very small (.001—.005 of an inch). One ball bearing race is clamped in place while the outer race of the other one is a slip fit in its mounting, thus allowing for expansion of the shaft.

BRUSH RING ..... **G3.**

GROUNDED G3.1

Indication: With a "dead ground" the generator will be short circuited and will not charge. With a partial ground, the generator may over-heat and appear to have a shorted armature.

Cause: Broken or burned insulation—metal chips, dirt and carbon dust on the brush ring.

Test: Raise the brushes from the commutator and test between the insulated brush and the generator head with a test lamp.

Remedy: Thoroughly clean the brush holder and brush ring insulation. If the insulation is damaged, it may be necessary to replace the brush ring or the insulation.

BRUSH SPRING WEAK G3.2

Indication: Charging rate low or unsteady—arcing at the brushes.

Cause: Brush lead loose or missing causing current to flow through the brush spring—excessive arcing of the brushes causing overheating of the spring—improper assembly of the spring.

Test: Test the spring tension—should be approximately 18 oz. Remy and 20 oz. Wagner. Exact value varies according to installation, but should be sufficient to hold the brush in good contact with the commutator.

Remedy: New spring. Make sure that the brush leads are in place.

BRUSHES SOFT OR OILY G3.3

Indication: Generator fails to start charging until the relay is closed by hand—Commutator may be glazed or blackened.

Cause: Wrong type brushes—imitation or unauthorized brushes—excessive lubrication of the commutator end bearing—oil on the brushes.

Test: Clean and polish the commutator (G1.51). This will cure the trouble temporarily, but if the brushes are at fault it will return.

Remedy: New brushes. When new brushes are installed, they should be carefully fitted to the commutator. This is accomplished by cutting a strip of sandpaper slightly wider than the brush and passing it around the commutator with the sanded side out. The brushes should then be allowed to rest on the sandpaper while the latter is drawn back and forth under it. (See Illus. No. 18). In this way the end of the brush will be curved to fit the curvature of the commutator. If the mica on the commutator has been undercut, the armature should be installed in the generator and the latter operated a few minutes before the commutator is polishd with sandpaper.
The slight burr left at edges of the bars will grind off the faces of the brushes until they fit the commutator properly. As soon as the brushes have been seated, the commutator should be polished with sandpaper to prevent further wear of the brushes.

BRUSH OR HOLDER STICKS ——— G3.4

Indication: Low or unsteady output—similar to weak brush spring.

Cause: With the hinged type brush holder; bent or rusty brush holder which does not turn freely on its hinge pin.

Test: Examine the brushes and holders to make sure they operate freely.

Remedy: Clean the brushes and holders, straighten or replace the brush holder.

FIELDS ——— G5.

SHORTED FIELD ——— G4.1

Indication: Depends on the location of the damage. If only a few turns are shorted, the effect is not noticeable. If a large part of the field winding is shorted out, the charging rate will be low or zero.

Cause: Damaged or defective insulation—field coils pinched while replacing the poles or other parts of the generator.

Test: Measure the field current. If it is abnormally high, the field is shorted. To locate the damaged coil, remove the tape at points where the coils are connected together and test each coil separately. Compare the current drawn by each coil; the damaged coil will draw a larger current than the other.

Remedy: Replace the damaged coil.

GROUNDED FIELD ——— G4.2

Indication: A grounded field is, in effect, the same as a shorted field.

Cause: Damaged or defective insulation—metal particles between the field coil and the frame or pole.

Test: Disconnect both ends of the field winding and test between the field lead and the frame with a test lamp. To locate the damaged coil, disconnect the coils and test each one separately.

Remedy: Re-insulate or replace the field winding.

OPEN FIELD ——— G4.3

Indication: Generator does not charge under any conditions.

Cause: Connections unsoldered. Winding may have been broken by accident or rough usage.

Test: Disconnect the ends of the field winding and measure the field current. If the field is open, the current will be zero. Remove the tape from the connections between the coils and test each coil separately. Make sure that the open is not due to a burned out thermostat. If the ends of the field are disconnected this will not be included in the test.

Remedy: If the break is in an external lead, it can be repaired. If the break is on the inside of the field coil, install a new coil.

FIELD BURNED OUT G4.4

Indication: Generator will not charge. Insulation on the field coil charred or burned.

Cause: Generator has been operated on open circuit or with a high resistance in the circuit. This causes the voltage to rise abnormally high, thus greatly increasing the field current.

Test: Examine the field winding for evidence of overheating.

Remedy: New field coils. On thermostatic generators, the field winding will not burn out while the thermostat is operating properly. Make sure that all wiring in the charging circuit is in good condition and that all connections are tight and clean, especially at the battery terminals.

FIELD COIL REVERSED G4.5

Indication: Generator output low or zero—field current normal.

Cause: Improper assembly or connections.

Test: Connect the field winding to a storage battery. Bring a small compass near each pole in turn (on the outside of the generator). The compass should indicate alternately north and south poles. If one field coil is reversed, the two poles will have the same polarity.

Remedy: Install or connect the field coil properly.

THERMOSTAT (REMY) ..... G5.

RESISTANCE BURNED OUT G5.1

Indication: Generator charges normally while cold but stops charging abruptly when it becomes hot and the thermostat opens.

Cause: Open or high resistance in the charging circuit which causes an abnormally high voltage, thus increasing the field current. When the thermostat opens, the increased current burns out the resistance.

Test: Examine the resistance—check the generator output, hot and cold.

Remedy: If the thermostat contacts have been burned, install a new thermostat. If the contacts are in good condition. the resistance unit only need be replaced. Make sure that the wiring between the generator and battery is in good condition and that all connections are tight and clean.

THERMOSTAT DOES NOT OPEN G5.2

Indication: Generator output high continuously—does not fall off abruptly when the generator becomes hot.

Cause: Thermostat blade bent—contacts welded together due to heavy arcing when resistance is burned out.

Test: Operate the generator at maximum output for thirty minutes. Make sure the field is not grounded to short out the thermostat.

Remedy: New thermostat.

THERMOSTAT DOES NOT CLOSE G5.3

Indication: Generator output low continuously.

Cause: Thermostat blade bent—dirt between the contacts thus preventing them from coming together.

Test: Operate the generator at maximum output and short out the resistance. If the thermostat is open, the generator output will increase when the resistance is shorted out. Make sure the thermostat connections are tight and clean.

Remedy: Clean the contacts by passing a strip of paper or cloth between them. Do not use emery cloth or sandpaper or pry contacts apart mort than 1/32 of an inch or the thermostat adjustment will be destroyed.

MISCELLANEOUS ..... G6.

POLARITY REVERSED G6.2

Indication: Relay contacts chatter and arc—contacts may burn and stick together—ammeter indicates unsteady "discharge."

Cause: Battery connections reversed—generator polarity reversed during test.

Test: With the engine not running, turn on the lights. Ammeter should read discharge. If the ammeter reads charge, the battery terminal connections have been reversed and the generator has the proper polarity. (Change the battery connections.) If the ammeter registers discharge, the battery is connected O.K., but the generator has reversed polarity.

Remedy: With the engine not running, close the relay contacts (be sure that the contacts separate) or interchange the battery connections.

POLES LOOSE G6.3

Indication: Generator noisy—armature laminations scored.

Cause: Screws which hold the poles or pole shoes have become loose or broken.

Remedy: Remove the armature and press the arbor in the frame and pole assembly and tighteen the screws. Inspect the armature to determine whether the core and winding has been damaged.

DISTRIBUTORS

CIRCUIT BREAKER ..... D1.

CIRCUIT BREAKER GROUNDED D1.1

Indication: Engine misfires or fails to start. Weak spark plug. Primary current does not decrease to zero when the contacts separate.

Cause: Metal chips or dirt on the circuit breaker base. Damaged insulation.

Test: Disconnect the low tension lead at the coil. Make sure that the contacts are separated and then test with a test lamp between the stationary contact and the distributor housing.

Remedy: Clean the circuit breaker assembly with gasoline. Examine the low tension lead and

the terminal where it is connected to the circuit breaker. If the ground persists after cleaning the circuit breaker, replace the circuit breaker plate on Remy or the stationary arm insulation on Wagner equipment.

CIRCUIT BREAKER WORN OR LOOSE (See D4.1) ——— D1.2

Indication: Engine misfires especially when the circuit breaker is in certain positions of advance or retard.

Cause: Loose nuts or weak spring washers on the underside of the circuit breaker plate.

Remedy: Tighten loose nuts. Replace weak or broken spring washers. If the circuit breaker plate and distributor housing are worn, replace these parts.

BREAKER ARM RUBBING BLOCK WORN OR BROKEN ——— D1.3

Indication: Small point opening—contact points may be burned. The engine may misfire. If the block is broken, the engine will not start.

Cause: Excessive spring tension on the breaker arm. Rough or rusty cam.

Test: Test the spring tension on the breaker arm. On Remy Equipment is should not exceed 20 oz. measured at the contact. On Wagner it should be from 9.5 to 11.5 oz. measured at the contacts.

Remedy: Adjust the spring tension. Use correct spring. If necessary, replace the breaker arm and cam.

POINT OPENING INCORRECT ——— D1.4

Indication: Engine misfires. If the point opening is too large, misfiring will be noticeable at high speed.

Cause: Wear on the breaker arm rubbing block. Loose lock nut on the stationary contact screw.

Test: With the rubbing block resting on the lobe of the cam, measure the distance between the contacts. This should be .020—.025 of an inch.

Remedy: Adjust the contacts and tighten the lock nut. (See Illus. No. 7).

CONTACTS BURNED, BROKEN OR DIRTY ——— D1.5

Indication: Misfiring of the engine. Engine may not start.

Cause: Damaged or defective spring. Spring not properly installed.

Test: Examine the contacts. Surfaces should be clean and smooth. If the contact surfaces have a frosted appearance, they are in good condition; however, there should be no pits or irregularities.

Remedy: Clean and smooth the contacts with a contact point file. Adjust the point opening to the correct value. Check the spring tension—replace the breaker arm or contact screw if the contacts are broken.

BREAKER ARM SPRING WEAK OR BROKEN ——— D1.6

Indication: Engine misses, especially at high speed. Engine may fail to start.

Cause: Damaged or defective spring. Spring not properly installed.

Test: Measure the spring tension. (See D1.3).

Remedy: Install a new spring or form the old one to give the necessary tension on Remy and install a new breaker arm on Wagner equipment.

DISTRIBUTOR CAP ..... D2.

CRACKED OR BROKEN D2.1

Indication: Engine misfires or fails to start.

Cause: Rough usage—cap fits too tightly on the housing.

Test: Examine the cap carefully for cracks or breaks.

Remedy: Replace the cap.

DISTRIBUTOR CAP BURNED D2.2

Indication: Engine fires irregularly. May appear to be out of time.

Cause: Contact opening incorrect.

Test: Examine the inside of the cap for evidence of burning between the inserts.

Remedy: New cap.

DISTRIBUTOR CAP INSERTS BENT, BURNED OR BROKEN D2.3

Indication: Broken inserts will cause missing under all conditions. A bent insert will usually cause the engine to miss when it is pulling heavily.

Cause: The heat of the spark jumping from the end of the rotor to the insert will in time burn the insert. However this action is slow and no ill effects will be noticed unless the insert is burned more than half way through. If the cap is not properly placed on the distributor, the rotor may strike the insert and bend or break it. Imitation or unauthorized rotors may also cause trouble of this kind due to the fact that they are not accurately made.

Test: Examine the inserts on the inside of the cap. All of them should be in place and they should extend straight down from the top of the cap.

Remedy: New cap. It is not advisable to attempt replacing these inserts as they must be located accurately and it is difficult to remove the old ones.

ROTOR ..... D3.

GROUNDED ROTOR D3.1

Indication: Engine misses or fails to start.

Cause: Cracked rotor.

Test: Examine the rotor—if no cracks are visible, make this test. With the distributor cap off, hold the end of the high tension lead from the coil about 1/8 of an inch from the metal insert of the rotor and then open the contact lever with the fingers. If a spark jumps the gap, the rotor is grounded.

Remedy: New rotor.

ROTOR SPRING BROKEN (Remy) D3.3

Indication: Engine misfires or fails to start.

Cause: Careless handling—rotor spring caught on the cap when replacing the cap.

Test: Examine the rotor.

Remedy: Replace the spring or rotor.

DISTRIBUTOR SHAFT BEARING WORN D4.3

Indication: Excessive side play in the distributor shaft. Engine may misfire.

Cause: Lack of lubrication.

Test: Examine the distributor for side play in the shaft—should be very small.

Remedy: Replace the housing and shaft if necessary. Make sure that the lubricating device is in good condition.

CONDENSER ..... D5.

OPEN CONDENSER D5.1

Indication: Contact points burned—ignition spark weak—engine misfires or fails to start.

Cause: Condenser not properly connected—lead to terminal broken. Poor ground connection—damaged condenser.

Test: Use 110 volt test lamp—connect across the terminals of the condenser—the lamp should not light (see Illus. No. 11).
Remove the test terminals and connect a wire or metal object across the condenser terminals (see Illus. No. 12).
A snappy spark should be obtained if the condenser is O. K. This test is preferably made with direct current but fair results will be obtained by using alternating current but a spark will not be obtained every time this test is tried.

Remedy: Check the condenser connections and leads, making sure that the ground contact with the distributor is clean and bright. If the condenser is at fault, replace it.

SHORTED CONDENSER D5.2

Indication: Engine misfires or fails to start. Primary current through coil is not broken when the contacts separate.

Cause: Damaged condenser.

Test: Use a test light and test across the condenser terminals. If the lamp lights, the condenser is shorted (see D5.1).

Remedy: Replace the condenser.

DISTRIBUTOR GEAR ..... D6.

LOOSE OR BROKEN D6.1

Indication: Distributor shaft is free to turn. Engine will not start—ignition out of time.

Cause: Distributor shaft may bind due to lack of lubrication.

Test: Attempt to turn the distributor shaft with the distributor mounted. If the shaft turns, the gear is loose or broken. Make sure the distributor shaft is not frozen in its bearing.

Remedy: Replace broken parts—make sure that the shaft is properly lubricated.

AUTOMATIC ADVANCE MECHANISM ..... D7.

DOES NOT ADVANCE D7.1

Indication: Engine sluggish—overheats—lacks power.

Cause: Weights bind or stick—sub shaft binds on main or driving shaft—spring tension excessive.

Test: Examine the automatic mechanism. Determine whether the weights move freely. See that the automatic cam shaft is free to turn about the driving shaft. See that the springs are fastened to the proper spring posts.

Remedy: Replace defective parts—lubricate the automatic cam shaft—use the proper springs.

DOES NOT RETARD D7.2

Indication: Engine knocks on a hard pull or when accelerated rapidly. May backfire when starting.

Cause: Automatic mechanism broken. Weights or shafts bind. Springs broken or missing.

Test: Examine the mechanism—check for free motion of the weights and automatic cam shaft—examine the springs.

Remedy: Lubricate the automatic shaft—replace the springs.

TIMING ..... D8.

TIMING LATE D8.1

Indication: Engine sluggish—overheats—lacks power.

Cause: Incorrect timing—cam slipped on shaft due to loose lock nut or screw.

Test: Check the timing.

Remedy: Retime (see Operation Article No. 17 or 18). Replace broken cam pin after having determined the cause of the breakage.

TIMING EARLY D8.2

Indication: Engine knocks on a hard pull or when accelerated. Backfires when starting.

Cause: Incorrect timing.

Test: Check the timing.

Remedy: Retime. (See Operation Article No. 17 or 18).

Note: If the distributor driving mechanism is loose or broken, the timing may be either early or late due to the mechanism having slipped. In case the timing has not been changed, examine the driving mechanism.

RELAYS

ADJUSTMENT INCORRECT ..... R1.

CUTS IN TOO SOON R1.1

Indication: Ammeter indicates discharge after the relay closes—relay contacts may chatter.

Cause: Improper adjustment—relay armature spring weak.

Test: Gradually increase the generator speed until the relay closes. Contacts should close positively and remain closed until the generator speed decreases. Aftr the relay closes, there should be a charging current of 1 to 3 amperes.
Note: Allow for ignition current where the current for ignition flows through the ammeter. If an ammeter is connected between the battery terminal of the relay and the lead which was removed from that terminal, it will not be necessary to allow for the ignition current.

Remedy: Adjust the relay. The general instructions cover three points.

1. Adjust the air gap between the relay armature and the core (contacts closed).
2. Adjust the gap between the contacts. (This is sometimes called "point opening"). Should be .012 to .015 of an inch.
3. Adjust the tension of the armature spring until a small charging current is

obtained when the relay closes. When the relay cuts out (contacts separate) the discharge current should not exceed two amperes.

CUTS IN TOO LATE R1.2

Indication: Charging current is more than 3 amperes immediately after the relay closes.

Cause: Incorrect adjustment. Relay armature hinge tight (Remy).

Test: Gradually increase the generator speed until the relay contacts close. Watch the ammeter and note the initial charging current when the relay cuts in. It should be not more than 3 amperes (see R1.1). Examine the armature to determine whether it moves easily.

Remedy: Adjust the relay (see R1.1). If necessary, file slots in the armature hinge until the armature moves easily (Remy).

CUTS OUT TOO SOON R1.3

Indication: Relay contacts separate before the charging current has decreased to zero.

Cause: Incorrect adjustment.

Test: Operate the generator at high speed and gradually slow it down until the relay contacts separate. Watch the ammeter and note the current at the instant the relay cuts out. This should be between 1 ampere charge and 2 amperes discharge.

Remedy: Adjust the relay (see R1.1).

CUTS OUT TOO LATE R1.4

Indication: Relay contacts do not separate until the discharge current is more than 2 amperes.

Cause: Incorrect adjustment—armature spring broken.

Test: Operate the generator at high speed and gradually slow it down until the contacts separate. Watch the ammeter. The current should not be more than 2 amperes discharge at the instant the contacts separate. Examine the armature spring.

Remedy: Adjust the relay (see R1.1). On Remy replace the relay if necessary.

DAMAGED RELAY ..... R2.

OPEN SHUNT WINDING R2.1

Indication: Generator does not charge until contacts are closed by hand. Thermostat resistance or field winding may be burned out (see also R2.7).

Cause: Broken wire or loose connections.

Test: Disconnect the relay from the generator. Connect the terminals of the relay together. If the shunt winding is open, no current will be drawn from the battery and the core will not be magnetized and will not attract the armature but if the shunt winding is O. K., there will be a noticeable pull on the armature and a small current dawn from the battery.

Remedy: Replace the relay.

SHORTED SHUNT WINDING R2.2

Indication: Generator does not charge until contacts are closed by hand. Shunt winding of the relay may be burned.

Cause: Rough usage, damaged insulation.

Test: Same as test for open, R2.1. If the shunt winding is shorted, a current will be

drawn from the battery but there will be no pull or only a slight pull on the armature.

OPEN SERIES WINDING R2.3

Indication: Relay closes normally but generator does not charge. If the relay is closed while the generator is not running, no current will flow through the generator.

Cause: Loose connections—broken wire.

Test: With the relay connected and the generator not running, close the relay points and if the ammeter does not show over three amperes discharge, the series winding is open.

Remedy: Loose connections may be soldered; otherwise replace the relay.

SHORTED SERIES WINDING R2.4

Indication: Relay does not stay closed at low charging rates—contacts chatter.

Cause: Damaged insulation.

Test: Trace the circuit and locate the connections to the ends of the series windings. Connect the series winding across the battery with a resistance in series so that a current of 15 to 20 amperes will flow. If the winding is O. K., there will be a noticeable pull on the relay armature. If the winding is shorted, there will be little or no pull on the armature.

Remedy: Replace the relay.

GROUNDED WINDINGS R2.5

Indication: A grounded winding will give the same indication and have the same effect as a shorted winding.

Cause: Damaged insulation—metal cover bent so that it touches the armature windings or terminals, or the cover screw may touch the armature. Connections on the underside of the relay may touch the surface on which the relay is mounted.

Test: Same as for shorts.

Remedy: Straighten or replace the cover, use a short screw in the cover (Remy), see that the connections on the underside of the relay do not touch the surface on which the relay is mounted. If the ground is internal, replace the relay.

CONTACTS BURNED R2.6

Indication: Relay action erratic—contacts tend to stick—relay may appear to be open circuited.

Cause: Cuts out too late, making it necessary for the contacts to separate while carrying a fairly heavy current. This may cause arcing and burning. Contacts chatter due to reversed generator polarity (see G6.2).

Test: Examine the contacts. They should be clean and should meet squarely when closed.

Remedy: Unless the contacts are badly damaged, they can be trued up with a contact file. Otherwise it will be necessary to install a new armature and stationary contact or replace the relay.

DIRTY RELAY R2.7

Indication: Relay apparently open circuited—contacts may not close.

Cause: Careless handling—cover missing—dirt between the contacts or between the core and armature will prevent the contacts from closing. Magnetism of the core attracts metal particles.

Test: Examine the relay.

Remedy: Clean the relay—adjust it if necessary.

COILS

PRIMARY WINDING ..... C1.

SHORTED C1.1

Indication: Ignition current abnormally large—weak spark—engine misses or fails to start.

Cause: Damaged or defective insulation in the coil. Overheating of the coil.

Test: Measure the current drawn by the coil. If it exceeds 6 amps. the primary winding is shorted.

Remedy: New coil.

GROUNDED C1.2

Indication: Engine misses or fails to start—weak spark—ignition current does not drop to zero when the contacts separate.

Cause: Damaged or defective insulation—on Remy metal top coils, the terminal screw may strike the cover.

Test: Test between either terminal and the coil base using a 110 volt test lamp. If the lamp lights, the primary is apparently grounded.

Make sure that the terminal screw does not ground on the cover due to a bent terminal or a long screw.

Remedy: Straighten the terminals—use short screws—if the trouble is internal, use a new coil.

OPEN C1.3

Indication: Engine will not start—no spark from the coil—no primary current.

Cause: Wire burned out—lead broken—coil top loose causing the wires to break.

Test: Test between the two terminals using a test lamp. If the lamp does not light, the winding is open. (Make sure the resistance unit is not open on Remy coil, see C4.1).

Remedy: New coil.

CONDENSER (REMY) ..... C3.

See D.5

SHORTED C3.1

Indication: Engine misfires or fails to start. Spark weak—primary current does not decrease to zero when the contacts are separated.

Cause: Damaged or defective condenser.

Test: Test the condenser, see D5.

Remedy: New condenser.

OPEN C3.2

Indication: Contacts burned—spark weak—engine misses or fails to start.

Cause: Not properly connected. Damaged condenser.

Test: Test the condenser, see D5.

Remedy: If the condenser is at fault, install a new one.

RESISTANCE UNIT (Remy) ..... C4.

OPEN C4.1

Indication: Engine will not start—no spark at the coil. No primary current through the coil.

Cause: Switch has been left on while the engine is not running. Loose connection between the generator and the battery causing excessive voltage. Broken wire.

Test: Use a test light and test between the "Battery" terminal of the coil and the screw through the center of the resistance unit. If the lamp does not light, the resistance unit is open.

Remedy: Install new resistance unit.

SHORTED C4.2

Indication: Coil overheats—primary current excessive.

Cause: Loose top on the resistance unit. Top bent or the insulation broken.

Test: With the distributor contacts closed, turn the ignition switch on. Current should not exceed 3 to 4 amperes. If the resistance unit is shorted, the current will be approximately 6 amperes.

Remedy: New resistance unit.

MISCELLANEOUS ..... C5.

COIL LEAKS WAX C5.1

Indication: Black, heavy wax with which the coil is filled leaks out around the bottom of the coil tube.

Cause: Overheating of the coil due to a shorted resistance (Remy) or a shorted primary winding. Loose connection between the generator and the battery will cause the generator voltage to rise and overload the coil.

Test: Examine the coil for evidence of wax leakage.

Remedy: If the coil performs satisfactorily, it need not be replaced. However, if the coil is weak, install a new one.

STARTING MOTORS

ARMATURE ..... M1.

SHORTED M1.1

Indication: Motor will not crank the engine or cranks it slowly.

Cause: Damaged or defective insulation on the armature.

Test: Test the armature with a growler (see G1.1).

Remedy: If the damage is readily accessible, it may be repaired; otherwise exchange the armature for a new one.

OPEN WINDING OR CONNECTION M1.2

Indication: Motor cranks the engine slowly or not at all. Poor commutation—commutator burned at the bars connected to an open circuited coil.

Cause: Connections unsoldered at the commutator.

Test: Examine the armature for evidence of loose connections.

Remedy: Resolder the connections or exchange the armature for a new one.

GROUNDED ARMATURE ——— M1.3

This has the same effect as the short and will give the same indications. See M1.1. For testing see G1.3.

ARMATURE RUBS POLE ——— M1.4

Indication: Motor noisy—armature laminations damaged—armature may be shorted.

Cause: Bent shaft—loose pole—worn bearings.

Test: Examine the motor—remove the armature and rotate it about its centers taking indicator readings, which will denote bent shaft.

Remedy: Shaft can usually be straightened; otherwise, exchange for a new armature—tighten the poles.

COMMUTATOR ——— M1.5
See G1.5

CLEANING COMMUTATOR ——— M1.51

Should the commutator be burned or dirty, it can be polished by rotating it while holding against it a piece of No. 00 sandpaper.

HIGH MICA ——— M1.52

Indication: Commutator burned—arcing at brushes while the motor is in operation.

Cause: Mica between the bars has not worn down as rapidly as the copper.

Test: Examine the commutator to determine whether the mica projects above the bars.

Remedy: Turn down the commutator (see G1.52) but do not undercut the mica between the bars.

GEAR TEETH BROKEN (GEAR REDUCTION MOTORS) ——— M1.6

Indication: Motor operation noisy—may fail to crank the engine.

Cause: Backfire of the engine—metal object in the gear case.

Test: Examine the armature.

Remedy: Replace damaged parts.

BRUSH RING ——— M2.

GROUNDED ——— M2.1

Indication: Motor cranks the engine slowly or fails to turn. Draws excessive current from the battery.

Cause: Damaged or defective insulation on the brush ring.

Test: Insulate the brushes from the commutator. Test between the brushes and the head of the motor with a 110 volt test lamp.

Remedy: Thoroughly clean the brush holder and brush ring insulation. If the insulation is damaged, it may be necessary to replace the brush ring.

NOT SET CORRECTLY ——— M2.2

Indication: Motor has low torque—poor commutation.

Cause: Brush ring not properly adjusted or the locking screws loose.

Test and Remedy: Adjust the brush ring so that the commutation is good when the motor is running at no load. Check the commutation when the motor is operating under load. The correct position of the brush ring will be found to be approximately ¼ bar back of neutral.

BRUSHES ——— M2.3

The brushes used on starting motors must carry heavy current and, therefore, are made of a material having low resistance. Brushes are usually made of copper gauze or a metal graphite composition. In order to provide lubrication for the gauze brushes two of the four brushes are impregnated with petrolatum. These brushes are marked with red paint to distinguish them from the brushes which are not impregnated.

When replacing gauze brushes, always use two impregnated brushes and two which are not impregnated. The metal graphite brushes are self lubricating and do not require any lubrication.

Gauze brushes are fitted to the commutator by tapping them lightly in place. Metal graphite brushes are seated by sanding them to fit the commutator in the same manner as carbon brushes are fitted to generator commutators (see G3.3).

BRUSHES WEAR RAPIDLY ——— M2.31

Indication: Brushes must be renewed at frequent intervals. Gauze brushes "fan out" or "mushroom."

Cause: Excessive brush spring tension—mica has been undercut.

Test: Examine the brushes for excessive spring tension. Note whether the mica has been undercut between the bars.

Remedy: Adjust the spring tension to the correct value (20-28 oz. Remy, 35 oz. Wagner) If the mica has been undercut, turn down the commutator.

BRUSH SPRING WEAK ——— M2.4

Indication: Poor commutation—commutator burned—motor cranks the engine slowly.

Cause: Brush spring burned due to loose pigtail on the brush which causes current to flow through the spring. Spring damaged or not properly installed.

Test: Raise the brush with finger to determine whether the spring has sufficient tension to hold the brush in good contact with the commutator. Look for loose screws which hold the pigtail to the head—note whether the pigtail is loose in the brush.

Remedy: New brush spring—tighten loose connections—if the pigtail is loose in the brush, install a new brush.

BRUSH OR HOLDER STICKS ——— M2.5

Indication: Motor cranks engine slowly—commutator burned—sparking at the brushes.

Cause: Holder has been damaged or is rusty.

Test: Examine the brushes and holder (make sure that the brush spring in O.K. 20-28 oz. Remy, 35 oz. Wagner).

Remedy: Straighten or replace damaged parts.

BEARINGS ——— M4.

WORN ——— M4.1

Indication: Excessive side play in the shaft—motor noisy—if the bearings are worn until the

armature strikes the pole, the armature laminations may be damaged.

Cause: Lack of lubrication—dirt or grit in the bearings.

Test: Examine motor—side play in the bearings should be very small.

Remedy: Install new heads, bearings or bushings. Make sure that the lubricating devices are in good condition.

TIGHT OR FROZEN M4.2

Indication: Motor turns slowly or not at all.

Cause: Lack of lubrication—bearings not properly aligned—shaft damaged.

Test: Examine the motor—turn the armature by hand to determine whether it moves freely.

Remedy: If bearing is not damaged, it can be cleaned and lubricated; otherwise, new parts may be necessary . Make sure that the lubricating devices are in good condition and that the armature turns freely in its bearings.

BENDIX PINION ASSEMBLY ..... M5.

SPRING DAMAGED M5.1

Indication: Pinion may not mesh with the flywheel.

Cause: Engine backfires when starting.

Test: Examine the bendix for evidences of damage to the spring.

Remedy: New spring. Check the ignition timing.

SPRING BOLT BROKEN M5.2

Indication: Pinion may not mesh with the flywheel—motor runs but does not crank the engine.

Cause: Backfire—bolt loose—incorrect or unauthorized bolt.

Cause: Examine the bendix.

Remedy: Install a new bolt. If the damage is due to backfire, check the ignition timing.

DIRTY OF GUMMY M5.3

Indication: Motor runs but the pinion does not mesh with the flywheel.

Cause: Dirt or heavy grease on the pinion and threaded shaft—in winter, oil on the bendix may congeal and prevent the pinion from moving along the threaded shaft.

Test: Examine the bendix—make sure that it is clean.

Remedy: Clean the bendix assembly with gasoline. Do not oil this device as it works better when dry.

EXCESSIVE LUBRICATION M5.4

Indication: Pinion jams against the flywheel teeth and locks the engine so that it cannot be cranked by hand.

Cause: Light oil on the bendix allowing pinion to move directly toward the flywheel teeth without rotating.

Test: Examine the bendix. It should be clean and dry.

Remedy: To loose the bendix pinion, place the transmission gears in high and rock the car backwards until the pinion loosens. Clean the bendix with gasoline.

PINION DAMAGED M5.5

Indication: Motor may not crank the engine or may be noisy in operation. If the counterweight is loose on the pinion, it will make a jingling sound.

Cause: Backfire—defective pinion—rough usage.

Test: Examine the pinion.

Remedy: Install a new pinion.

GEARS ..... M7.

WORN OR BATTERED M7.1

Indication: Motor operation noisy—armature does not revolve smoothly when turned by hand.

Cause: Lack of lubrication—dirt or metal particles in the gear case.

Test: Disassemble motor and examine the gears.

Remedy: If the gears are badly damaged or worn, install new ones. Clean out the gear case thoroughly and repack with fresh grease.

BROKEN M7.2

Indication: Motor operation noisy, but does not crank the engine.

Cause: Backfire.

Test: Disassemble the motor and examine the gears.

Remedy: Replace broken parts—check the ignition timing.

MISCELLANEOUS ..... M8.

LEAD OR TERMINAL BROKEN M8.1

Indication: Motor will not operate. If the lead touches the frame or grounded part of the motor, a heavy current will be drawn; otherwise, no current will flow.

Cause: Vibration or rough usage—terminal may have been tightened excessively.

Test: Examine the terminal and lead.

Remedy: Replace broken parts.

POLES LOOSE M8.2

Indication: Motor noisy—armature core may be damaged and the armature shorted.

Cause: Loose screws or rivets in the poles.

Test: Examine the poles and armature.

Remedy: Tighten loose parts—if necessary, replace the armature.

GEAR OR BENDIX HOUSING BROKEN M8.3

Indication: Motor cranks the engine slowly or not at all.

Cause: Backfire—broken teeth on the flywheel.

Test: Examine the housing.

Remedy: New housing—make sure that the ignition is properly timed.

SWITCHES

STARTING SWITCHES ..... S1.

GROUNDED S1.1

Indication: Motor cranks the engine slowly or not at all. Excessive current drawn from the battery.

Cause: Damaged or defective insulation—terminal on the cable touches switch case.

Test: Disconnect the cables from the battery and starting motor, then connect an ammeter between the battery cable and battery terminal. If current flows, the switch is grounded on the battery side. Close the starting switch. If current flows, the switch is grounded in the plunger or on the motor side. The meter used should be of 300 amperes capacity.

Remedy: Repair or replace the switch.

OPEN S1.2

Indication: Motor will not run. No current drawn from the battery.

Cause: Broken terminal—insulating material between the contacts.

Test: Close the starting switch and note whether the motor turns. Connect a piece of heavy copper wire or starting cable across the starting switch terminals. If the motor runs, the switch is open.

Remedy: Repair or replace the switch.

STICKS S1.3

Indication: Motor does not start when the starting switch is released.

Cause: Plunger spring broken—plunger bent—terminals or movable contact loose.

Test: Note whether the motor stops when the starting switch is released. Test the action of the switch plunger to determine whether it moves freely.

Remedy: Repair or replace the switch.

LIGHTING SWITCH ..... S2.

POOR CONTACT S2.1

Indication: Lights dim or flicker.

Cause: Contact spider weak or loose—contacts dirty or corroded.

Test: Disassemble the switch and examine the contacts and spider.

Remedy: Clean and tighten the spider, clean the contacts. If the spider is weak or burned, install a new one.

GROUNDED S2.2

Indication: Current drawn from the battery when the switch is in the "off" position. Excessive current drawn when the lights are burning.

Cause: Damaged insulation—insulation may have been burned due to heavy current caused by a short circuit in the wiring.

Test: Disconnect the wires from the switch and test between the switch terminals and the case with a 110 volt test lamp.
To test the spider, remove the fibre base plate and test from the spider points to the switch bracket. If the lamp lights the spider is grounded.

Remedy: Install a new insulating washer under the spider. Install a new fibre base plate assembly.

DIMMER RESISTANCE SHORTED ——— S2.5

Indication: Lights burn brightly in both "dim" and "bright" positions of the switch. Wire in the resistance bent or pressed together. Insulation burned allowing the ends of the wire to come together.

Cause: Examine the resistance.

Test: Re-form the wire or install a new resistance unit.

DIMMER RESISTANCE BURNED OUT ——— S2.6

Indication: Lights will not burn when the switch is in the "dim" position.

Cause: Short circuit or ground in the light circuit. Use of large bulbs which draw larger current than resistance was designed to carry.

Test: Turn the light switch to the "dim" position and short out the resistance. If lights burn, the resistance is open or burned out.

Remedy: New resistance unit.

MISCELLANEOUS

WIRING ..... X1.

GROUND OR SHORT ——— X1.1

Indication: Excessive current flows through the wiring affected—fuses "blow"—insulation burns off the wires—if the current passes through the ammeter, the pointer may go off the scale on the discharge side.

Cause: Bare wire or terminal comes in contact with metal part of the engine or with another wire, usually due to damaged or defective insulation.

Test: Use a test lamp. Disconnect both ends of the wire or make sure that it is not grounded through the lights or other equipment and then test from one end of the wire to ground or to another wire in the circuit being tested. If the lamps light, the wire under test is grounded or shorted to the other one. Inspect the wire to locate the exact point at which the trouble occurs.

Remedy: Re-insulate the wire or terminal. The most satisfactory repair is made by installing a new wire.

OPEN ——— X1.2

Indication: No current flows through circuit—apparatus in that circuit does not operate.

Cause: Broken wire or connection—terminal unsoldered (check for blown fuses).

Test: Disconnect the ends of the wire and apply the terminals of a test lamp to the ends of the wire. If the lamp does not light, the wire is open circuited. Examine the wire to locate the exact point at which the trouble occurs. Occasionally a wire will break inside the insulation.

Remedy: Splice the wire or, preferably, install a new one. Resolder broken or loose connections.

LOOSE CONNECTION ——— X1.3

Indication: Unsteady or fluctuating current in the circuit—erratic action of apparatus in that circuit (such as flickering lights).

Cause: Broken wire, loose terminal nut or screw, connection unsoldered.

Test: Carefully examine all connections in the circuit affected. Turn on the switch and pull or shake the wires and note whether such action affects the apparatus in use.

Remedy: Tighten or resolder connections. Replace broken wire.

HIGH RESISTANCE X1.4

Indication: Current in the circuit affected is less than normal—apparatus in the circuit affected does not operate at normal efficiency; for instance, lights may be dim, ignition weak or horn sluggish.

Cause: Loose or corroded connections—wires partially broken—wire too small for the current it carries—fuses loose in clips—switch contacts burned or corroded.

Test: Use a piece of heavy flexible wire to "shunt" the various wires in the circuit affected (connect this wire to the two ends of the suspected wire). When the damaged wire or connection has been shunted, the current will rise to its normal value and the apparatus will function normally.

Remedy: Clean and tighten connections. Replace the wire if necessary.

BATTERY ..... X2.

DISCHARGED OR DAMAGED X2.1

Indication: Starting motor cranks the engine slowly or not at all—lights dim with the engine at rest or idling but increase to normal brilliancy when the engine operates rapidly.

Cause: Damaged or defective battery—ground or short in the wiring—excessive use of current—slow driving which does not permit the generator to charge the battery.

Test: Test the specific gravity of all cells with a hydrometer. If the hydrometer reading is 1.225 or more, the battery is apparently O. K., but it should be given further tests by a competent battery repairman as there are certain classes of battery trouble that are not indicated by the hydrometer.

Remedy: Repair or recharge the battery.

TERMINAL CORRODED OR BROKEN X2.2

Indication: Starting motor will not crank the engine—generator voltage high—burns out the lights—if the engine is stopped, it may not start again because of weak spark.

Cause: Corrosion on battery terminal—terminal post broken due to excessive strain or defect in lead.

Test: Turn on the lights (if the terminal is not entirely broken off, the lights will burn) and close the starting switch. If the terminal is corroded or broken, the lights will go out. Hold down the switch about one half minutes and then touch the battery terminals. Damaged terminal will usually be warm.

Remedy: Clean off corrosion and coat the terminal with vaseline. If the terminal post is broken, have the battery repaired.

LEAKS X2.3

Indication: One cell requires water more frequently than the rest—electrolyte level drops below the top of the plates.

Cause: Crack or break in the hard rubber jar of the cell at fault.

Test: See indication. Look for evidence of acid leakage from the battery.

Remedy: Have the battery repaired—new jar will be necessary.

SPARK PLUGS ..... X4.

BROKEN OR DIRTY X4.1

Indication: Engine misfires on one or more cylinders—good spark obtained from the cable when it is disconnected from the plug.

Cause: Carbon or oil on the insulator (porcelain or mica)—porcelain cracked or broken due to heat of the engine or accidental damage.

Test: Examine the plug for evidence of damage—testing spark plugs in the open air is not reliable as the defect may not become apparent unless the plug is under compression.

A positive test can be made by substituting another plug (known to be O.K.) in place of the suspected one. Note whether the engine fires regularly on the new one.

Remedy: Clean carbon and oil from the insulator. If the insulator is damaged, install a new one or replace the spark plug.

GAP BETWEEN POINTS TOO WIDE X4.2

Indication: Engine misfires when pulling heavily or when accelerated rapidly.

Cause: Incorrect adjustment—points burned or bent.

Test: Remove the plug and check the gap between the points. This should be .025 of an inch.

Remedy: Adjust the points to obtain the correct gap.

GAP BETWEEN POINTS TOO SMALL X4.3

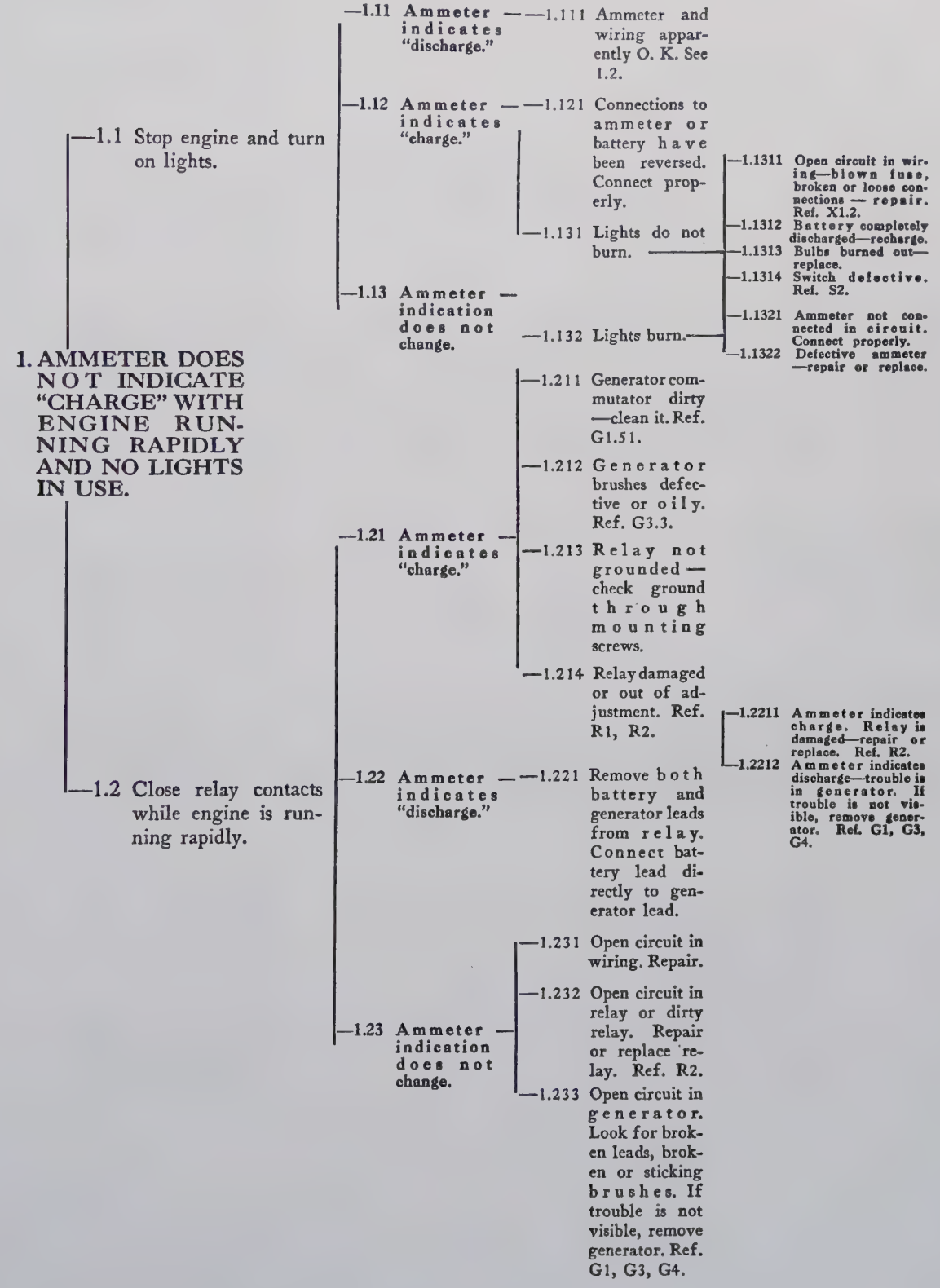
Indication: Engine misfires when idling or when running under a light load.

Cause: Incorrect adjustment—points bent.

Test: Remove the plug and check the gap between the points. This should be .025 of an inch.

Remedy: Adjust the points to obtain the correct gap.

CHART FOR SYSTEMATIC TROUBLE SHOOTING


1. AMMETER DOES NOT INDICATE "CHARGE" WITH ENGINE RUNNING RAPIDLY AND NO LIGHTS IN USE.
1.1 Stop engine and turn on lights.
1.2 Close relay contacts while engine is running rapidly.
1.11 Ammeter indicates "discharge."
1.111 Ammeter and wiring apparently O. K. See 1.2.
1.12 Ammeter indicates "charge."
1.121 Connections to ammeter or battery have been reversed. Connect properly.
1.131 Lights do not burn.
1.1311 Open circuit in wiring—blown fuse, broken or loose connections — repair. Ref. X1.2.
1.1312 Battery completely discharged—recharge.
1.1313 Bulbs burned out—replace.
1.1314 Switch defective. Ref. S2.
1.13 Ammeter indication does not change.
1.132 Lights burn.
1.1321 Ammeter not connected in circuit. Connect properly.
1.1322 Defective ammeter—repair or replace.
1.21 Ammeter indicates "charge."
1.211 Generator commutator dirty—clean it. Ref. G1.51.
1.212 Generator brushes defective or oily. Ref. G3.3.
1.213 Relay not grounded — check ground through mounting screws.
1.214 Relay damaged or out of adjustment. Ref. R1, R2.
1.2211 Ammeter indicates charge. Relay is damaged—repair or replace. Ref. R2.
1.2212 Ammeter indicates discharge—trouble is in generator. If trouble is not visible, remove generator. Ref. G1, G3, G4.
1.22 Ammeter indicates "discharge."
1.221 Remove both battery and generator leads from relay. Connect battery lead directly to generator lead.
1.23 Ammeter indication does not change.
1.231 Open circuit in wiring. Repair.
1.232 Open circuit in relay or dirty relay. Repair or replace relay. Ref. R2.
1.233 Open circuit in generator. Look for broken leads, broken or sticking brushes. If trouble is not visible, remove generator. Ref. G1, G3, G4.

2. AMMETER INDICATES "CHARGE" BUT BATTERY BECOMES DISCHARGED.

—2.1 Question driver as to driving conditions.

- —2.11 **Slow driving.**
  - —2.111 Explain that car must be driven at a moderate speed before generator can charge the battery.
  - —2.112 If driving conditions compel slow driving, generator output should be increased slightly.
- —2.12 **Abnormal amount of night driving.**
  - —2.121 Explain operation of generator as in 2.111.
  - —2.122 Increase generator output slightly.

—2.2 Check for excessive demand on battery.

- —2.21 **Excessive use of starting motor.**
  - —2.211 Frequent stops — increase generator output slightly.
  - —2.212 Difficulty in starting engine — advise owner to have engine "tuned up."
- —2.22 **Excessive use of lights.** — —2.221 Advise economizing on use of lights — parking lights save current.
- —2.23 **Added electrical equipment.**
  - —2.231 Explain to owner how extra lights (of high candle power bulbs)—hand warmers, cigar lighters, electric windshield wipers, etc., draw current from battery.
  - —2.232 Generator output may be increased slightly.

—2.3 Disconnect battery lead from relay and connect a reliable ammeter in the circuit. Check maximum generator output.

- —2.31 **Output normal or higher.** — —2.311 See 2.4.
- —2.32 **Output low.** — —2.321 Increased to normal.

—2.4 Disconnect lead at battery and connect a reliable ammeter in the circuit. Make sure all switches are "off" and note whether current flows.

- —2.41 **No current flows.**
  - —2.411 Wiring apparently O. K. have battery tested for internal troubles.
  - —2.412 Electrical equipment O. K. See 2.1 and 2.2.
- —2.42 **Current flows.** — —2.421 Test wiring to locate short circuit, ground or defective switch. Ref. X1.1. Make sure relay cuts out (Ref. R1.4).

3. GENERATOR OVERHEATS. —3.1 Connect a voltmeter between generator terminal and ground. Check voltage at maximum generator output.

—3.11 **Voltage normal—trouble is in generator—look for damaged armature or field or grounded brush ring (Ref. Gl, G3 G4).**

—3.12 **Voltage high—high resistance in charging circuit. Look for loose connection (Ref. X1.3), corroded battery terminals (Ref. X2.2). The so-called "dry" storage batteries may cause generator voltage to rise excessively.**

4. GENERATOR STOPSCHARGING WHEN IT BECOMES HOT. —4.1 Remove cover band and short out thermostat resistance. (This applies only to thermostatic generators. For others, see 4.12.)

—4.11 **Generator charges—Thermostat resistance burned out. Replace and correct trouble in charging circuit (Ref. G5.1).**

—4.12 **Generator does not charge—armature or field opens or shorts when hot (Ref. Gl and G4).**

5. STARTING MOTOR DOES NOT RUN AND IS NOT ENGAGED WITH ENGINE.

- 5.1 Turn on lights and close starting switch.
  - **5.11 Lights dim normally.**
    - 5.111 Test battery on high discharge rate or substitute another battery. If battery is O. K., remove motor and test. Ref. M1 to M8.
  - **5.12 Lights do not dim: See 5.2.**
  - **5.13 Lights go out: Hold switch closed one-half minute, then touch all connections in starting circuit.**
    - 5.131 One or more connections warm: Clean and tighten or repair. Ref. X2.2.
    - 5.132 No connections warm: Battery defective. Ref. X2.1.
- 5.2 Short out starting switch with a piece of heavy cable.
  - **5.21 Motor runs: Starting switch at fault. Ref. S1.2.**
  - **5.22 Motor does not run.**
    - 5.221 Lights dim normally: Switch at fault. Ref. S1.2. See also 5.11.
    - 5.222 Lights go out: Switch at fault. Ref. S1.2. See also 5.13.
    - 5.223 Lights do not dim: If cables are O. K. there is an open in the motor. Remove it for test. Ref. M1, M2, M3.

6. STARTING MOTOR RUNS IDLY WITHOUT ENGAGING WITH ENGINE.

—6-1 Motors fitted with bendix drive—Check for following: (Remove motor if necessary).

- —6.11 **Broken bolt or spring.**——Replace—install spring supports—check timing. Ref. M5.1, M5.2, D8.
- —6.12 **Heavy or gummy oil on bendix screw shaft.**——Wash off with gasoline—do not lubricate. Ref. M5.3.
- —6.13 **Retard pin sticks or binds.**——Repair or replace. Ref. M5.7.
- —6.14 **Teeth broken off flywheel.**——Check ignition timing. Ref. M5.8, D8.
- —6.15 **Improper screw shaft on bendix (wrong thread).**——Check against parts list.

—6.2 Motors having reduction gears—Check for following:

- —6.21 **Teeth stripped on armature shaft or gear.**——Replace—check ignition timing. Ref. D8, M7.2.
- —6.22 **Key sheared in pinion or gear.**——Replace—check keyways and ignition timing. Ref. D8.

—6.3 Motors used with over-running clutch—Check clutch for following:

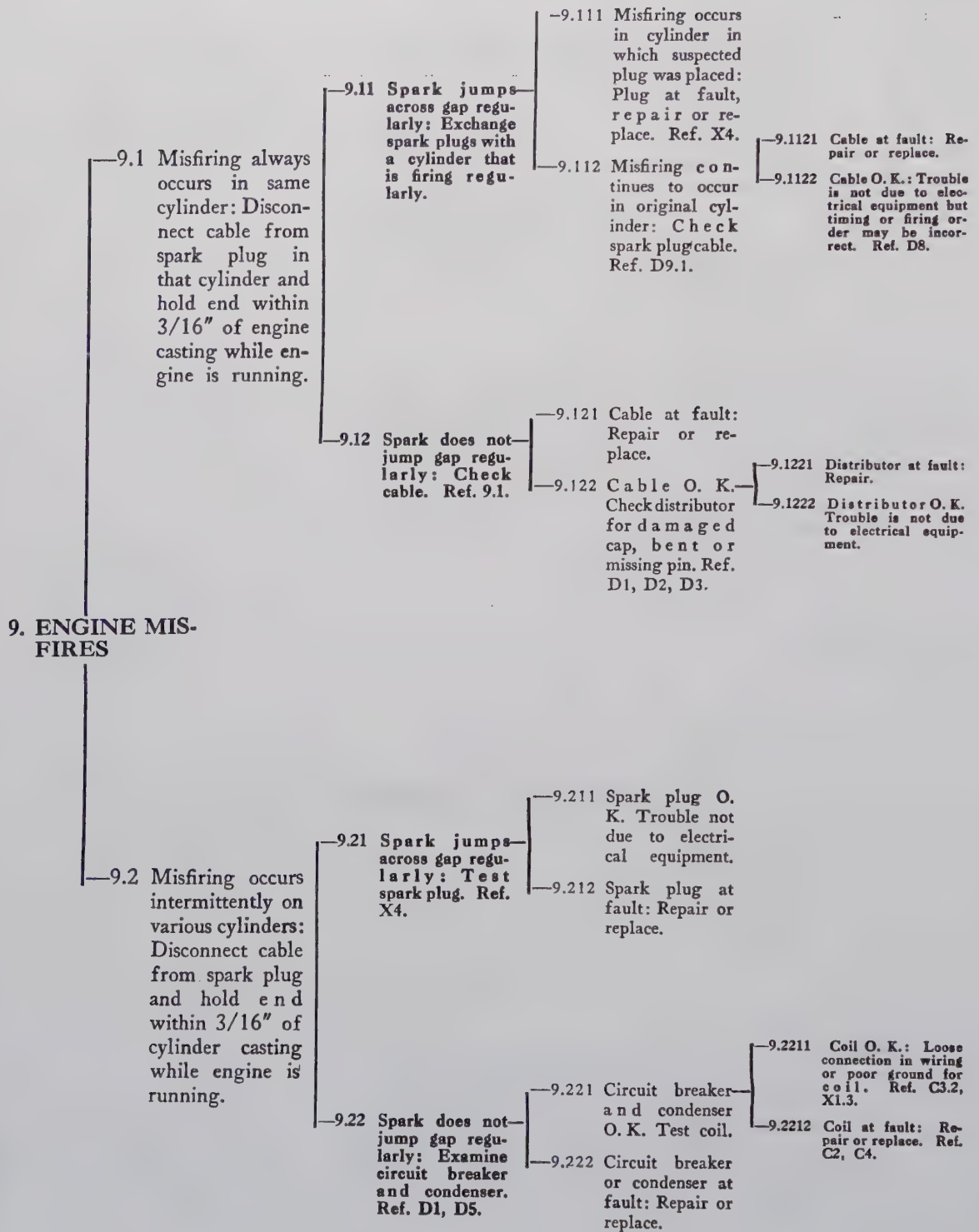
- —6.31 **Broken rollers or pawls.**——Replace—check ignition timing. Ref. M6.1, D8.
- —6.32 **Worn parts.**——Replace. Ref. M6.3.
- —6.33 **Key sheared in driving member.**——Replace.

7. STARTING MOTORS CRANKS ENGINE SLOWLY OR NOT AT ALL.

- 7.1 Turn on lights and close starting switch.
  - 7.11 **Lights dim normally: See M7.2.**
  - 7.12 **Lights go out: Keep switch closed one-half minute, then touch all connections in starting circuit.**
    - 7.121 One or more connections warm: Clean and tighten. Ref. X2 2.
    - 7.122 No connections warm: Install a good, fully charged battery.
      - 7.1221 **Motor O. K., trouble is in battery.**
      - 7.1222 **Motor operation not appreciably better. Remove motor for internal test. Ref. M1, M2, M3.**
- 7.2 Short out starting switch with a piece of heavy cable.
  - 7.21 **Motor operates normally: Switch is at fault. Ref. S1.**
  - 7.22 **Motor operation does not change.**
    - 7.221 Lights dim normally: Switch O. K. See M7.3.
    - 7.222 Lights go out: Switch at fault. See also M7.12.
- 7.3 Crank engine by hand.
  - 7.31 **Engine cranks easily: See M7.4.**
  - 7.32 **Engine stiff or hard to crank: Locate and remedy stiffness in engine.**
- 7.4 Turn motor armature by hand.
  - 7.41 **Armature turns freely: Make internal tests. Ref. M1, M2, M3.**
  - 7.42 **Armature not free to turn: Check for frozen bearing, armature rubbing pole or pinion jammed against flywheel. Ref. M4, M5.4, M5.8.**

8. ENGINE WILL NOT START.

- 8.1 Turn ignition switch on. Remove wire from spark plug and hold within 3/16" of plug terminal. Crank engine by hand.
  - 8.11 **Spark jumps gap: Check timing and firing order. Ref. D8.**
    - 8.111 Timing incorrect: Retime. Ref. D8.
    - 8.112 Timing is O. K.: Trouble is not in ignition system (make sure spark plugs are O. K. Ref. X4).
  - 8.12 **No spark occurs at gap. Check contacts and wire to distributor. Ref. D1, D9.2. If these are O. K., see 8.2.**
- 8.2 Hold a metal object against coil base and within 3/16" of high tension terminal on coil. Make sure contacts are closed, then separate them quickly by moving the breaker arm with the finger.
  - 8.21 **Spark jumps gap: Trouble is in high tension wiring. Repair or replace. Ref. D9.1.**
  - 8.22 **No spark occurs at gap. See 8.3.**
- 8.3 Disconnect distributor lead from coil. Hold one end of a wire on timer terminal of coil and brush other end against metal part of engine.
  - 8.31 **Flash occurs indicating flow of current: Remove coil for test.**
    - 8.311 Coil O. K.: Trouble is in distributor. Ref. D1 or condenser. Ref. D5.
    - 8.312 Coil weak or damaged: Repair or replace. Ref. C.
  - 8.32 **No flash occurs: See 8.4.**
- 8.4 Disconnect from coil the wire from switch. Brush wire against metal part of engine.
  - 8.41 **Flash occurs indicating flow of current: Coil or resistance is open. Ref. C1.3, C4.1.**
  - 8.42 **No flash occurs.**
    - 8.421 Open circuit or high resistance in wiring or at battery. Ref. X1, X2.
    - 8.422 Switch defective or damaged. Ref. S2.


9. ENGINE MISFIRES
9.1 Misfiring always occurs in same cylinder: Disconnect cable from spark plug in that cylinder and hold end within 3/16" of engine casting while engine is running.
9.11 Spark jumps across gap regularly: Exchange spark plugs with a cylinder that is firing regularly.
9.111 Misfiring occurs in cylinder in which suspected plug was placed: Plug at fault, repair or replace. Ref. X4.
9.112 Misfiring continues to occur in original cylinder: Check spark plug cable. Ref. D9.1.
9.1121 Cable at fault: Repair or replace.
9.1122 Cable O. K.: Trouble is not due to electrical equipment but timing or firing order may be incorrect. Ref. D8.
9.12 Spark does not jump gap regularly: Check cable. Ref. 9.1.
9.121 Cable at fault: Repair or replace.
9.122 Cable O. K. Check distributor for damaged cap, bent or missing pin. Ref. D1, D2, D3.
9.1221 Distributor at fault: Repair.
9.1222 Distributor O. K. Trouble is not due to electrical equipment.
9.2 Misfiring occurs intermittently on various cylinders: Disconnect cable from spark plug and hold end within 3/16" of cylinder casting while engine is running.
9.21 Spark jumps across gap regularly: Test spark plug. Ref. X4.
9.211 Spark plug O. K. Trouble not due to electrical equipment.
9.212 Spark plug at fault: Repair or replace.
9.22 Spark does not jump gap regularly: Examine circuit breaker and condenser. Ref. D1, D5.
9.221 Circuit breaker and condenser O. K. Test coil.
9.222 Circuit breaker or condenser at fault: Repair or replace.
9.2211 Coil O. K.: Loose connection in wiring or poor ground for coil. Ref. C3.2, X1.3.
9.2212 Coil at fault: Repair or replace. Ref. C2, C4.

GENERAL INFORMATION

Electrical Unit Types

DICTATOR MODEL ER & EU 1926-1927

Lighting Switch	Delco-Remy	420-J
Ignition Coil	Delco-Remy	284-S
Ignition Dist.	Delco-Remy	626-K
Ignition Switch	Delco-Remy	440-A
Starter Motor	Delco-Remy	720-N
Generator	Delco-Remy	941-K
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	406-J

DICTATOR MODEL EU—1927

Lighting Switch	Delco-Remy	420-J
Ignition Coil	Wagner	K-789
Ignition Dist.	Wagner	K-815
Ignition Switch	Delco-Remy	440-A
Starter Motor	Wagner	S-533
Generator	Wagner	S-509
Relay	Wagner	K-44
Starter Switch	Delco-Remy	406-J

DICTATOR MODEL GE—1928

Lighting Switch	Delco-Remy	484-D
Ignition Coil	Delco-Remy	525-E
Ignition Dist.	Delco-Remy	636-Y
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	720-N
Generator	Delco-Remy	949-J
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	406-N

BIG & SPECIAL 6—MODEL EP & EQ 1926

PRES. 6 & COM.—MODEL ES & EW—1927

Lighting Switch	Delco-Remy	420-K
Ignition Coil	Delco-Remy	284-S
Ignition Dist.	Delco-Remy	626-W
Ignition Switch	Delco-Remy	440-A
Starter Motor	Delco-Remy	723-B
Generator	Delco-Remy	941-L
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	406-B

PRES. 6 & COM.—MODEL ES & EW—1927

Lighting Switch	Delco-Remy	420-K
Ignition Coil	Wagner	K-789
Ignition Dist.	Wagner	K-889
Ignition Switch	Delco-Remy	440-A
Starter Motor	Wagner	S-503
Generator	Wagner	S-602
Relay	Wagner	K-880
Starter Switch	Delco-Remy	406-B

COMMANDER MODEL GB & GH—1928

Lighting Switch	Delco-Remy	484-D
Ignition Coil	Delco-Remy	525-E
Ignition Dist.	Delco-Remy	636-X
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	723-B
Generator	Delco-Remy	941-L
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	406-B

PRESIDENT 8 MODEL FA—1928

Lighting Switch	Delco-Remy	484-D
Ignition Coil	Delco-Remy	525-E
Ignition Dist.	Delco-Remy	658-J
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	724-H
Generator	Delco-Remy	949-U
Relay	Delco-Remy	265-B

PRESIDENT 8 MODEL FB—1928 (2 Coil)

Lighting Switch	Delco-Remy	484-D
Ignition Coil	Delco-Remy	525-E
Ignition Dist.	Delco-Remy	668-A
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	724-H
Generator	Delco-Remy	955-C
Relay	Delco-Remy	265-B

ERSKINE MODEL 51 and 52

Lighting Switch	Delco-Remy	484-E
Ignition Coil	Delco-Remy	525-A
Ignition Dist.	Delco-Remy	639-R
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	712-H
Generator	Delco-Remy	940-G
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	405-C

ERSKINE MODEL 50

Lighting Switch	B & S.	
Ignition Coil	Delco-Remy	525-A
Ignition Dist.	Delco-Remy	637-Y
Ignition Switch	Hershey	
Starter Motor	Delco-Remy	712-G
Generator	Delco-Remy	942-B
Relay	Delco-Remy	265-B
Starter Switch	Delco-Remy	405-C

Issued July 1, 1929
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PRINTED IN U. S. A.

Wagner Equipment on Studebaker Cars

STANDARD SIX

K-789 Coil
S-509 Generator
K-815 Ignition-Distributor
K- 44 Relay
S-533 Starting Motor
K-822 Starting Switch
K- 71 Condenser
K-837 Ignition Switch

BIG AND SPECIAL SIX

K-789 Coil
S-508 Generator
K-866 Ignition-Distributor
K-870 Ignition-Distributor, fan type
K- 44 Relay
S-503 Starting Motor
K-822 Starting Switch
K-819 Condenser
K-837 Ignition Switch

Remy Equipment on Studebaker Cars

STANDARD SIX

265-B Relay
626-K Distributor (with condenser)
284-S Coil
720-M Starting Motor
917-A Generator
406-B Starting Switch

BIG AND SPECIAL SIX

266-E Relay
626-L Distributor (with condenser)
626-S Distributor, fan type (with condenser)
284-S Coil
723-A Starting Motor
917-E Generator
406-B Starting Switch

DESCRIPTION OF UNITS

Ignition Coil (See Illus. No. 1 and 2)

The Remy ignition coil consists of an iron core, made up of soft iron laminations, around which and insulated from it, is placed the primary winding. This consists of a few hundred turns of No. 16 copper wire. (See Illus. No. 37).

Over the primary winding and insulated from it, is placed the secondary winding. This consists of several thousand turns of very fine wire. One end of the secondary winding is grounded to the coil core and base, the other end is connected to the high tension terminal on the side of the coil.

A resistance unit connected in series with the primary winding is placed on top of the coil to limit the amount of current that will flow through the primary winding and keep it from burning out when the ignition switch has been left on after the engine is stopped. The resistance of the wire increases rapidly as the coil heats. Since the resistance increases as the unit heats, it gives the coil the further distinct advantage of operating satisfactorily at low and high speeds and on low as well as high battery voltage.

The condenser on Remy Models is mounted on the distributor breaker plate under the cap.

The Wagner ignition coil consists of an iron core, made up of soft iron laminations around which, and insulated from it, is placed the secondary winding. This consists of several thousand turns of very fine wire. One end of the secondary winding is connected to the primary terminal which is marked "Switch". This acts as the secondary ground and eliminates the necessity of grounding the coil base to the engine. The other end of the secondary is connected to the high tension terminal on the top of the coil. (See Illus. No. 35).

Over the secondary winding and insulated from it, is placed the primary winding. This consists of a few hundred turns of medium-sized wire, the ends of which are brought out at the two terminals located at the top of the coil and marked "Switch" and "Timer."

The condenser on Wagner Models is mounted on the side of the distributor.

ACTION OF COIL

When the current flows through the primary winding at the time the circuit breaker contacts are closed, the iron core is magnetized. When the contacts open (these are set to open at the correct time by a proper timing of the distributor with the engine) the magnetism dies out very rapidly and induces a high voltage in the secondary winding. This high voltage is then distributed to the proper spark plug and in jumping the spark plug gap, fires the compressed gas in that cylinder.

The condenser consists of two strips of tinfoil wound together and insulated from each other by very thin paper. It serves as the electrical reservoir which prevents excessive sparking of the circuit breaker contacts. The condenser also discharges back through the primary winding and causes a more rapidly dying flux with a more intense secondary spark.

DISTRIBUTOR

The distributor performs three functions:

1. It makes and breaks the low tension ignition circuit at the proper time.
2. It distributes the high tension current from the coil to the spark plugs in the proper firing order.
3. It provides a means (fully automatic) of advancing and retarding the spark to correspond to the variations in engine speed.

The making and breaking of the ignition low tension current is accomplished by the circuit breaker mechanism which consists of:

1. A six lobed cam connected to the engine crank shaft through the distributor drive and timing gear.
2. Two contacts: One stationary (insulated) and one mounted on a grounded arm held against the cam by the arm spring. The lobes of the cam cause the contacts to open and close. (See Illus. No. 3).

The high tension current of the coil is distributed to the cylinders by the rotor and cap. The rotor fits the main shaft in one position only. The high tension lead of the coil is connected to the center terminal of the cap which makes contact with the rotor segment through the carbon brush. The segment, as it rotates with the engine, conducts the current to the terminal connected to the cylinder in firing position at that moment. The segment does not make actual contact to the terminal pin

but passes very close (1/64 of an inch) to it. The current jumps the gap and is carried to the cylinder by the heavy insulated wire connected to that terminal.

The Remy automatic device consists of two weights held toward the center of rotation (shaft) and against the cam star by springs. The cam and cam star being held firmly on the sub-shaft, a movement of one means a corresponding movement of the other. As soon as the distributor starts rotating, these weights are thrown outward and acting upon the cam star advance the cam.

The Wagner automatic device consists of two weights mounted on the plate of the main shaft and held against the sub-shaft on which the cam is assembled by springs. As soon as the distributor starts rotating, these weights are caused to distend and acting on the sub-shaft advance the cam.

GENERATOR

The generator is driven by the engine and automatically recharges the storage battery. When the engine is operating at high speed, the current for lights and ignition is taken directly from the generator, but when the generator is at rest or running slowly, the current is taken from the storage battery.

At a car speed of approximately ten miles per hour, the generator develops a voltage sufficient to supply current to the storage battery and is automatically connected into the circuit by the relay.

As the car speed increases, the generator voltage increases, supplying more and more current until it furnishes more current than is used by the lights and ignition. The surplus is delivered to the battery (ammeter shows charge).

The maximum output occurs at approximately 25 miles per hour. As the speed increases beyond this point, the current delivered by the generator gradually decreases.

The regulation is accomplished by the third brush method. (See Illus. No. 15 and 16). The position of this third brush in relation to the main brush determines the maximum output. This is properly adjusted at the factory and should not be changed unless the adjustment is found to be incorrect for driving conditions. (Check ammeter for incorrect reading).

On Remy equipment, in addition to the third brush regulation, the thermostat is installed:

1. To insure a charged battery in winter as well as summer and thus insure maximum battery life.

2. To protect the generator in case of excessive generator voltage due to broken leads or loose connections in the battery circuit. Excessive current would be forced through the fields and seriously damage the field windings if the resistance did not act as a fuse and burn out.

The thermostat is connected in series with the field and consists of a thermostatic switch shunted by a resistance. (See Illus. No. 19). Normally the contacts are closed and permit a maximum charging rate to the battery. As the generator heats to approximately 160° F. the contacts open due to heat warping the thermostat blade. The field current now flows through the resistance, which causes the field current to be reduced, thereby reducing the charging rate of the generator by approximately one-half.

Maximum Charging Rate

REMY

Cold 18-20 Amperes (Thermostat closed) (Passengers Cars)

Hot 9-12 Amperes (Thermostat open) (Passenger Cars)

Cold 25-27 Amperes (Thermostat closed) (Bus Chassis)

Hot 16-18 Amperes (Thermostat open) (Bus Chassis)

WAGNER

Cold Big and Special Six 15-17 Amperes

Cold Standard Six 14-16 Amperes

RELAY

The relay is simply an automatic switch which connects and disconnects the generator and storage battery. If the storage battery were left connected to the generator when the engine slows down or stops, current would flow from the battery through the generator windings and discharge the battery. The relay acts as a check valve which permits current to flow from the generator to the storage battery, but which opens the circuit whenever the current starts to flow from the battery back through the generator.

The connection is made through two contacts, one connected to the generator through the series coil, and the other connected to the battery. They are held open at low speeds by a spring fastened to the relay armature and are closed magnetically by the generator voltage at higher speeds. (See Illus. No. 21 and 22).

The voltage or shunt coil is wound with a large number of turns of very fine wire and permanently connected across the generator terminals. This winding induces enough magetism to close the contacts when the generator has built up sufficient voltage for charging the battery.

The series coil has a comparatively few turns of heavy wire. This winding is connected in the charging circuit in series with the contacts and the generator. After the shunt coil has caused the contacts to close, the current from generator to battery passing through the series coils sets up a magnetism which assists in holding the contacts closed securely as long as the current continues to flow to the battery. When the current starts flowing from the battery (due to the engine's slowing down or stopping) the magnetism set up by the series coil reverses so that instead of holding the contacts closed, it opposes the magnetism set up by the shunt coil. The result is that there is insufficient magnetism left to hold the relay armature down and the spring forces the contacts apart. (See Illus. No. 39).

STARTING MOTOR

The starting motor, as its name implies, cranks the engine during starting.

The starting motor is series wound, i. e., the same current that passes through the armature also passes through the field winding. This gives the necessary high torque at low speed required to crank the engine. The windings are of heavy copper wire or strap.

The motor and engine on the Standard Six are connected and disconnected by the bendix drive. (See Illus. No. 28). The Bendix pinion operates upon a hardened steel screw sleeve which is fastened to the starting motor shaft through the Bendix spring by a set screw. The pinion has a lateral travel along this screw for engaging it with the teeth on the flywheel. The Bendix spring, besides serving as the flexible coupling between the starting motor shaft and the Bendix, facilitates the engagement of the gears and absorbs all shocks. The power is supplied to the motor by the battery, to which it is connected through the starting switch. (See Illus. No. 29 and 40).

When the starting switch is pressed down the starting motor is connected to the battery and the armature, being free, revolves at a high rate of speed. The Bendix pinion. by reason of its inertia, tends to lag behind the rotating shaft whose screw thread thus draws the pinion into mesh with the teeth of the flywheel. As soon as the engine fires, its increased speed of rotation threads the pinion in the opposite direction, disengaging the motor from the engine.

The starter and engine on Models Big and Special Six are connected by a one-way clutch and chain. When the starter switch is pressed down, the motor turns rapidly and the clutch engages and drives the engine. With the engine running under its own power, the starter and chain are idle, after the starter switch has been released.

AMMETER

Correct Ammeter Readings

The ammeter indicates what is taking place in the storage battery circuit. When current is going into the battery, the ammeter should indicate "charge" and when current is being drawn out of the battery, it should indicate 'discharge." The current taken by the starter motor does not go through the ammeter and hence is not indicated by it.

With the engine at rest and the lights not in use, the ammeter hand should stand at the zero position. When lights are being used the hand should be on the discharge side of the scale. If, under these conditions, the ammeter indicates charge, the connections to it have been reversed or the polarity of the battery has been changed.

The ammeter "charge" reading will decrease suddenly when the thermostat opens after a few miles continuous driving.

With the engine running rapidly and no lights in use the ammeter hand should be on the charge side of the scale. When lights are being used, the hand may be on either side of the scale, depending

on the speed of the engine and amount of current taken by the lights. Normally the hand should be on the charge side when the car is running about fifteen miles an hour, but will swing over on the discharge side as the car slows down.

When the hand goes out beyond the last mark on the discharge side of the scale it indicates that the relay contacts are stuck together or that there is a ground or short circuit which should be located and corrected at once. Where a fuse is used to protect the wiring it should "blow" in case of a short circuit or ground and open the circuit.

Checking Ammeter Indications

To check the accuracy of the ammeter readings, connect a reliable ammeter in series with it and compare the readings of the two. The ammeters used on motor vehicles are not precision instruments as they are built to withstand vibration and rough usage, but they are sufficiently accurate for checking the normal operation of the electrical equipment. However, it is advisable to use a good portable ammeter whenever exact readings are required.

SPARK PLUGS

Spark plugs play an important part in the ignition system and we would suggest the use of only the make and type of plugs as furnished with our cars or at any rate, a plug of known quality. There are any number of cheap as well as high priced plugs on the market for which many claims are made, but which, at the same time, do not give good results. We therefore wish to caution against the use of any plugs not known to be satisfactory.

Faulty plugs often cause troubles such as lack of power, engine missing, etc., for which other things are incorrectly blamed.

Setting Spark Plug Points

To give best results, see that the spark plug points are set to a .025 of an inch gap. Do not make this setting by guess or use a thin dime, as the correct gap cannot be obtained in this manner. Always use a .025 of an inch thickness gauge.

Care must be used in setting the points, not to break them.

After the plugs are used in the engine for some time a portion of the points (electrodes) will burn away, making the gap wider than .025 of an inch. Spark plugs should therefore, be removed occasionally and the points re-set if the gap is not correct.

Cleaning Spark Plugs

Cleaning of spark plugs is occasionally necessary in order to remove carbon deposit on the porcelain and shell and prevent the plug from being short circuited.

How often a plug should be cleaned will depend on several conditions. Plugs will require more frequent cleaning when too much oil reaches the combustion chamber, when the gasoline mixture is too rich, or when the engine is missing due to ignition or valve trouble (valves not seating properly).

To clean the plugs, disassemble them and wipe off all carbon from the porcelain with a rag, moistened with gasoline. Never scrape or sand carbon off of the porcelain as this will cause carbon to deposit more rapidly and also weaken the insulating qualities of the porcelain. Scrape out the inside of the plug shell, clean the points and reassemble, making sure that the two copper and asbestos gaskets are in good condition and in place. Set the points according to the above instructions before placing the plugs in the engine.

Care must be taken in assembling the plug and placing it in the engine, not to crack the porcelain.

STORAGE BATTERY

A Storage Battery is an electro-chemical apparatus entirely different from the mechanical parts of the car.

The work of repairing a battery should be attempted only by one experienced in battery work. Therefore, no battery repair operations will be included in these instructions but only such information as is needed in general care of a storage battery.

Testing of Battery

The most reliable test of the condition of charge of a storage battery is by means of a hydrometer, which shows the exact specific gravity of the solution in each cell.

The specific gravity of electrolyte is the ratio of the weight of the sulphuric acid solution to the weight of water.

Take the weight of distilled water as a standard and call it "1". Sulphuric acid weighs more than water, so that when it is added to water, as it is to make the battery solution, the solution will naturally weigh more than the original water. It is this increased weight which we measure.

If the battery is properly charged, the battery solution should weigh one and 29/100 times as much as water. This weight is called specific gravity and is usually shown as 1.290.

The hydrometer proper (Illus. No. 31) is a short glass tube closed at both ends and with a graduated scale on the upper part of it. When placed in the solution, the hydrometer will float and where the surface of the fluid crosses the graduated scale, the exact specific gravity of the solution can be read.

But as it is difficult and impractical to pour electrolyte from the battery in order to have it tested, a device is needed to draw the solution up around the hydrometer. This device is known as a "hydrometer syringe." It is a glass tube in which the hydrometer is enclosed, but capable of moving freely. A rubber bulb at the top of the syringe is used to draw up the solution around the hydrometer.

To assemble the hydrometer syringe ready for use, remove the rubber bulb and stopper from the top and insert the hydrometer with the weighted end down. (The hydrometer is packed in a separate case to protect it from breakage). Replace the rubber stopper and wet the top end of the glass barrel; replace the bulb and the syringe is ready for use.

To measure the specific gravity of the liquid in a cell: Squeeze the bulb of the hydrometer syringe, and holding it in a vertical position, insert the flexible rubber end into the opening of the battery. (Illus. No. 33). Then slowly release the bulb, allowing the liquid to be drawn into the hydrometer syringe tube. You will notice the hydrometer proper will begin to float and move up with the liquid. It is necessary to so regulate the amount of electrolyte drawn into the tube that the hydrometer will be freely suspended without touching on top or the sides when the bulb is fully released. The line of fluid where the hydrometer emerges from it will show the exact specific gravity of the fluid as shown by figures in the scale (Illus. No. 31).

With a little practice the reading of the hydrometer will not be difficult. The reading should be taken before water is added for otherwise it would be impossible to get the true reading of the solution. *After testing return the electrolyte to the same cell from which it was taken.*

Electrolyte should be tested at least once every two weeks and in hot climates once a week, to determine the level of the liquid and its specific gravity. The specific gravity should be tested immediately after the battery is charged and before distilled water is added.

Addition of Water

As explained before, electrolyte is a solution of sulphuric acid consisting of one part of acid (of 1.875 specific gravity) and about 2 2/3 parts of distilled water. Unless renewed from time to time, the water will evaporate from the solution, making its specific gravity greater.

When electrolyte is standing in an operative battery, the evaporation of water is hastened by the heat generated inside the battery. For this reason it is necessary to replace it, because as soon as the solution gets below the tops of the plates, the part of the plate exposed becomes inoperative through lack of contact with electrolye and through sulphation. Besides the solution becomes stronger, hastening the deterioration of the plates and separators between the plates.

Furthermore, owing to the fact that the electrolyte covers only part of the plates, the current is forced to pass through a much smaller area than originally intended, thus unduly heating the plates and causing them to warp, permanently injuring the battery.

In adding distilled water, care should be taken that not more than ½ inch (1 c/m) of fluid be above the plates.

Temperature of Electrolyte in a Battery

It is injurious to the battery to have it become overheated when the temperature of electrolyte exceeds 110° F. (43° C.). This may be caused by several conditions. One reason might be that the battery has become fully charged on a long motoring trip, but still the generator continues supplying current to the battery at a high rate, with consequent heating of plates and eventual warping.

Overheating may also be caused by the battery standing a long time idle and the electrolyte consequently becoming low, through evaporation of water. A certain degree of sulphation or hardening of the plates will have set in and the plates be-

ing unable to stand the usual rate of charging will rapidly heat, with subsequent warping or buckling.

Care of Battery

1. On a new car, first see that the battery is properly and securely fastened in its place, for if left loose, the jarring of the car may ruin a brand new battery beyond repair.

2. Instruct the owner to keep the battery clean and dry.

3. The battery should be tested at least once every two weeks to determine the level of the liquid and its specific gravity.

After testing the gravity electrolyte should be returned to the same cell from which it was drawn.

4. The electrolyte level should always be kept about ½ inch (1 c/m) above the tops of plates. When testing the battery (every two weeks), add distilled water only if the electrolyte is below the specified level. To obtain a true reading, the testing with a hydrometer of the specific gravity (density) of the solution in batteries must be done before water is added.

5. When all cells are in good order, the gravity will test about the same (within 20 points) in all.

Gravity at 1.290 indicates a battery is fully charged.

Gravity at 1.250 indicates a battery is more than three-quarters charged.

Gravity at 1.215 indicates a battery is half charged.

Gravity at 1.180 indicates a battery is about one-quarter charged.

Gravity below 1.150 indicates a battery completely discharged or "run down." (For remedy see chart, page 48).

Note—For specific gravity used in tropical countries, see page 47.

6. Should the level of liquid continue lower, in any one cell in spite of regular additions of water, it is evident that there is a leakage due to a cracked jar. The battery should be immediately taken to a battery service station for repairs, otherwise the battery may be ruined.

7. Gravity in one cell much lower than in the others, especially if successive readings show the difference to be increasing, indicate that the cell is not in good order (for reasons and remedy see chart, page 48.

8. Do not under any circumstances add acid to the electrolyte in the battery to increase its specific gravity, except in very special cases, where the electrolyte is known to have been spilled out. This should only be done by an expert battery man.

As explained before, the original electrolyte contains a sufficient amount of acid and the plates can absorb only a certain portion of it, therefore, adding more acid to it will make the solution too strong, with the result that the plates and insulation will become seriously injured.

9. The battery should never be allowed to overheat. Remember that on a long drive during the day, with but few stops, the battery will become fully charged. However the generator will continue charging, sending electric current through the battery, and consequently the battery begins to overheat, which if prolonged, will loosen the active material from the plates. As yet, there is no satisfactory device on the market that would automatically disconnect the battery from the generator. Therefore, the only practical way of preventing this trouble is to burn all the lights in case the connectors on the top of the battery are more than blood warm to the touch, thus relieving the battery from the overload.

If it is noticed that the battery is often becoming overheated, it is quite possible that the generator charges too high, in which case it might be advisable to have the generator adjusted.

10. If, for any reason, the specific gravity of the solution, as indicated by two successive tests, can not be brought up to the proper point by the regular operation of the generator when the car is running, the battery should be removed from the car and charged from an outside source, using direct current.

11. A battery which is to stand idle for two or three months, should first be fully charged and then a freshening charge given it at least once a month, as a fully charged battery will discharge itself completely in 90 days.

12. A fully charged battery will not freeze even at a very low temperature. The danger of freezing increases with the state of discharge.

Sp. Gr.	Freezes at (Fahr.)	Cent
1.290	— 90	— 67.7
1.250	— 60	— 51
1.215	— 25	— 32
1.180	— 8	— 22
1.150	5	— 15

Even if there were no danger of freezing, a one-half charged battery would quickly deteriorate due to sulphation, which sets in when the battery is in a discharged or partly discharged state.

The sulphation that takes place is in the form of a white substance that covers the surface of the active material and if the battery is left in that condition, the sulphation will penetrate further into the active material making it harder and harder. If not left too long in this state, such plates may be restored to usefulness by being charged at a much lower rate, for a longer period of time than would be required at the standard rate. Only in this way, however, can the sulphation be broken up without injury to the plates. This may take, in some cases, as long as two or three weeks. If the rate is too high the plates will become overheated and will buckle, which is ruinous to the battery.

Note—It is to be remembered that at 10° F. (—12½° C.), the efficiency of a battery decreases about 50%.

13. Put vaseline on the battery terminals; this will prevent corrosion.

14. Instruct the car owner that if the engine does not start readily, not to exhaust the battery in uselessly turning the starter. If the engine fails to start, on being turned over several times by the starter, it must be concluded that something is wrong with the gas supply or ignition and in such case a more careful investigation should be made.

15. As the average car owner often has not the time nor inclination to attend personally to the care of the battery he should where possible, give a Willard Service Station an opportunity to serve him. They will gladly test his battery every two weeks, adding the necessary distilled water and should the battery need charging or repairing, they will be able to advise him. In this way, the life of the battery will be greatly prolonged.

Most Important Points to Observe in Battery Care

(a) Test the battery at least once every two weeks (once a week in hot weather).

(b) Add distilled water regularly to keep the level of the electrolyte ½ inch above the top of the plates.

(c) Never use a battery in a leaky condition, but have the jar replaced.

(d) Do not allow the battery to become overheated; should the temperature be over 110° F. (43° C.) burn all the lights.

Preparing Threaded Rubber Insulated Charged Bone Dry Battery for Service

When possible, the work of preparing batteries for service should be taken care of by a Williard Service Station. If no Willard Service Station is available the work can easily be taken care of as instructed in Operation Article No. 15.

Preparing Electrolyte

The electrolyte, or storage battery acid, is diluted sulphuric acid and must be pure and suitable for storage battery purposes. All sulphuric acid purchased should be specified for "storage battery use."

Electrolyte can be purchased of the proper density (1.290 specific gravity) for preparing "bone dry" batteries for service or it may be purchased of 1.400 specific gravity which can be diluted to 1.290 gravity by mixing 10 parts (by volume) of 1.400 electrolyte with 4½ parts (by volume) of distilled water.

Pure concentrated sulphuric acid can be purchased and prepared for "bone dry" batteries according to the following directions:

Mix one part (by volume) of concentrated sulphuric acid with 2 2/3 parts (by volume) of distilled water. Sulphuric acid always should be poured into the water (*never the water into the acid as this is dangerous*) and the solution allowed to cool below 90° before it is placed in the battery.

All electrolyte should be mixed and kept in glass, earthenware, or hard rubber containers.

In all cases where it is necessary to mix 1.290 electrolyte the temperature of the electrolyte should be read with a thermometer graduated in Fahrenheit degrees, so that no electrolyte with a temperature higher than 90° F. is placed in the battery. A hydrometer test should be made at the same time to be sure of 1.290 specific gravity before it is placed in the battery.

In filling a battery, the electrolyte should be poured into the cells by means of a lead or glass funnel.

See Operation Article No. 15, for preparing the battery.

Tools Used for Preparing Batteries

All these items can be secured from any Willard Service Station.

1. *Electrolyte*

Electrolyte can be purchased of the proper density (1.290 specific gravity) for preparing Bone Dry batteries for service.

Electrolyte can be purchased of 1.400 specific gravity, which can be diluted to 1.290 gravity by mixing 10 parts (by volume) of 1.400 electrolyte with 4½ parts of distilled water.

Pure concentrated sulphuric acid of 1.835 specific gravity can be purchased and prepared for Bone Dry batteries according to instructions above.

2. *Porcelain Pitcher*

A porcelain pitcher should be used for handling and pouring sulphuric acid and electrolyte. A metal dish (except lead) should never be used, because the acid attacks the metal and the resulting impurities in the electrolyte will prevent the proper operation of the battery. A large letter "A" should be printed on the pitcher to distinguish it from a pitcher containing distilled water.

It may be found convenient to keep the distilled water in pitchers. If this is done the pitcher containing acid or electrolyte should be marked as mentioned above. The one containing water, without any mark on it, can be distinguished from those containing acid.

3. *Hydrometer*

A hydrometer syringe must be used to test the gravity of the elecytrolyte in the battery cells and also to determine the gravity of any solution of acid before it is placed into the battery. The specific gravity is the best indication of the actual condition of the cells.

4. *Lead Funnel*

A lead funnel should be used for filling the cells with electrolyte. A glass funnel may be used, but they are easily broken.

5. *Thermometer*

A thermometer graduated in Fahrenheit degrees should be used to obtain the temperature of the electrolyte before it is put into the battery and also during the time the battery is on charge. The type known as the dairy thermometer is well adapted for this purpose. Electrolyte over 90° F. should not be placed in a battery. If the temperature of the electrolyte exceeds 110° F. during a charge, the rate of charging current should be reduced.

6. *Battery Clips*

Lead plated battery clips should be used for connecting the batteries in series during a charge and also to the charging circuit. These clips should be connected in pairs with rubber covered wires.

Charging

In charging, only direct current should be used. Never attempt to use alternating current because material harm will result to the storage battery. If nothing but alternating current is available the battery charger described in Vol. 8 can be used for charging.

During the charge care must be taken to have the battery terminals connected to the proper leads of the charging circuit. The positive terminal of the battery must be connected to the positive terminal of the charging circuit.

If more than one battery is to be charged, the positive terminal of one battery must be connected to the negative terminal of the next battery. This is called a "series" connection and the circuit is shown in Illus. No. 30.

A dairy thermometer should be placed in the middle cell of a battery so as to obtain the temperature of the electrolyte.

If during the charge, the temperature exceeds 110° F. the charging rate of current should be reduced, so as to keep the temperature below 110° F.

While the battery is on charge, the vent plugs should be removed from each cell. The temperature and gravity of the electrolyte should be taken at regular intervals of time during a charge. When the gravity does not show any further rise for two consecutive readings at intervals of four hours, the battery can be taken off charge.

After the charging has been completed, the vent plugs should be replaced.

If direct current is available a battery charger will not be necessary. The batteries can be charged directly off the line. An ammeter with a full scale reading of about 10 amperes should be placed in the charging circuit. Sufficient resistance should be used in series with the battery (Illus. No. 30) to reduce the current to the finish rate" of the battery, which is stamped on the plate on the side of the battery case.

Temperature Corrections in Specific Gravity

In mixing acid or making gravity readings of batteries, particular attention should be paid to temperature as a correction should be made in the gravity which will vary inversely as the temperature. The standard temperature at which all gravity corrections are made is 80° Fahr.

Illus. No. 34 shows the corrections to be applied, adding for temperatures below 80° and subtracting for those above 80°.

Example—Gravity reads 1.290 and temperature is 60°. To correct for normal, subtract 8 which gives 1.282 at 80°.

Gravity reads 1.270 and temperature is 110°. To correct for normal add 12 which gives 1.282 at 80°.

STORAGE BATTERY TROUBLE CHART

SYMPTOMS / CAUSE	Battery Undercharged.	Battery Overcharged.	Battery Neglected, No Water Added.	Too Much Water Added When Filling.	Battery Accidentally Emptied of Solution	Battery Badly Sulphated.	Battery Reversed In Charging.	Battery Completely Discharged.	Leaky Jar.	Acid Spilled on the Connections.	Broken Connections Between Generator and Battery—Terminals Loose.	Battery Worn Out.	Short Circuit Between Plates.	Generator not Charging Properly.	Short Circuit in the Wiring.
Gravity Less Than 1.215	AJ										O			O	O
Very Low Gravity or no Reading Obtainable on Hydrometer.	A			A		AML	AL	A			IJ		BD	O	G
No Solution in Cell			ML		FD				CDL						
Battery will not take Charge						ML					IJ	N	BD	O	O
Battery Charged one Day Discharged Over Night												DN	BD		GI
Battery will not Crank Engine	A		AML		FAD	AML	AL	A	CDL	IJ	J	N	BD	O	O
Battery Box Wet or Rotted				HE					CDH						
Battery Very Hot		K												KJO	
Terminals Corroded										HI					
Lights Flare Up and Sometimes Burn Out											OJ				

REMEDY

A. Needs charging.
B. Needs reinsulation.
C. Replace jar.
D. Have work done by Willard Service Station or a good battery man.
E. Fill only to ½ inch above plates.
F. Let experienced battery man replace the electrolyte.
G. Go over the wiring system to find the leak.
H. Clean battery and the inside of battery compartment with cloth moistened in ammonia; this will neutralize acid.
I. Clean and grease terminals with vaseline.
J. Tighten terminals and all connections.
K. Burn all lights.
L. Give long charge at low rate.
M. Add water.
N. If in service for four years replace with new battery.
O. Take car to Studebaker dealer for readjustment and for testing.

Ignition Cable Terminal

It is very important that the high tension cable terminal be firmly seated in the coil connection in cars that have the coil mounted on the dash. When the cable is properly seated it will require considerable effort to pull it from the coil connection.

Drain Holes in Lighting Switch

Effective on President Eight cars with serial No. 6001197, Commander 4047305, and Dictator 1419202, the lighting switches, were furnished with drain holes. The drain holes are so located that any water entering the switch will drain out and eliminate the possibility of the switch becoming inoperative due to freezing in cold weather.

Lighting Switch Fuse

A twenty ampere lighting switch fuse has been released for use in the Erskine six. The change from a ten ampere fuse, to one of twenty ampere capacity, has been made to reduce the possibility of over loading the fuse when all the lights are turned on at one time. The twenty ampere fuse can be installed in cars of previous production to replace the ten ampere fuse.

Buzzer or Current Limit Relay

There are no fuses on the President Eight, Commander after serial number 4039801 and Dictator after serial number 1410001. The buzzer is a protective device which takes the place of the fuses previously used in the lighting circuits. It is located on the back of the instrument board on the right hand side.

Normal amounts of current to the lighting circuit do not affect the relay or circuit breaker but an abnormally heavy current, such as would flow in case of a ground in any of the lighting circuits, will cause the circuit breaker to operate.

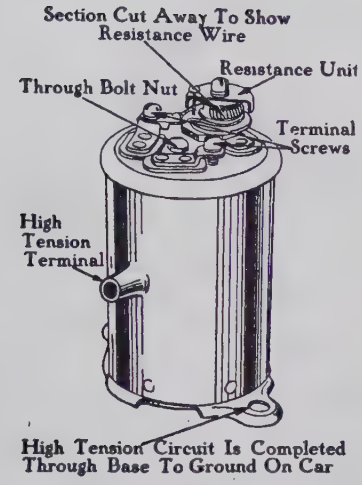
The buzzer will ordinarily require no attention but if, at any time, the lights fail to burn when the switch is turned on there is a possibility that the points of the buzzer have stuck open—causing an opening in the lighting circuit.

To correct this all that is required is to touch the flat spring on the end of the buzzer with the finger. If the points are sticking this will close the circuit and the lights will burn. However, never touch the buzzer when it is sounding as it is hot and may burn the hand.

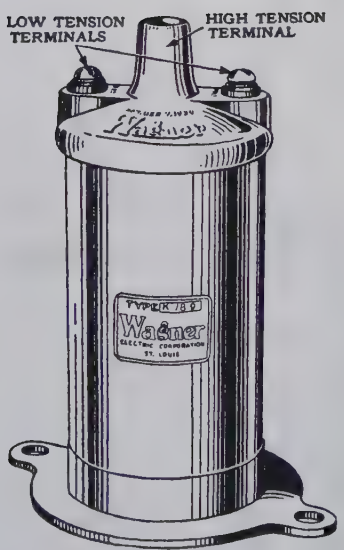
Issued July 1, 1929
Insert in Volume Seven after page 48

PRINTED IN U. S. A.

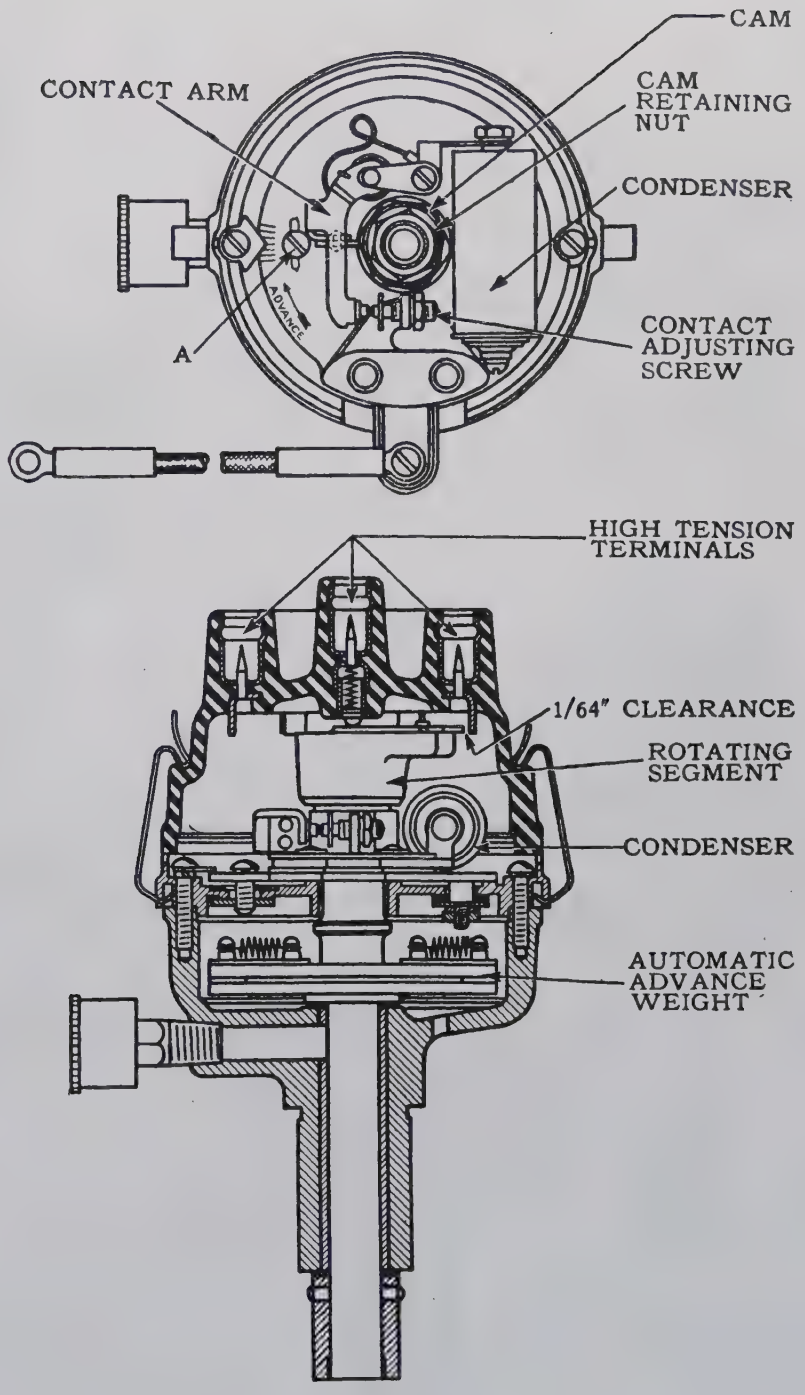
ILLUSTRATIONS


Section Cut Away To Show Resistance Wire
Resistance Unit
Through Bolt Nut
Terminal Screws
High Tension Terminal
High Tension Circuit Is Completed Through Base To Ground On Car

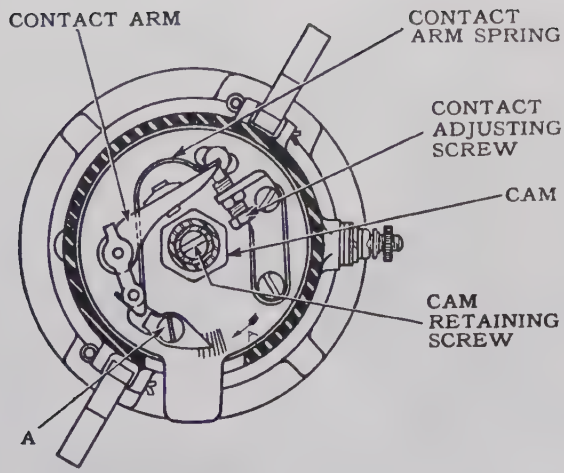
Illus. No. 1
Remy Ignition Coil

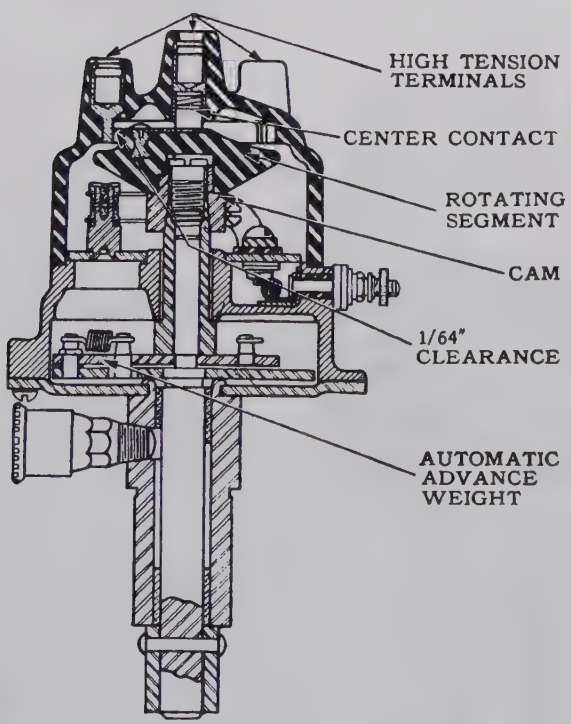


Illus. No. 2
Wagner Ignition Coil

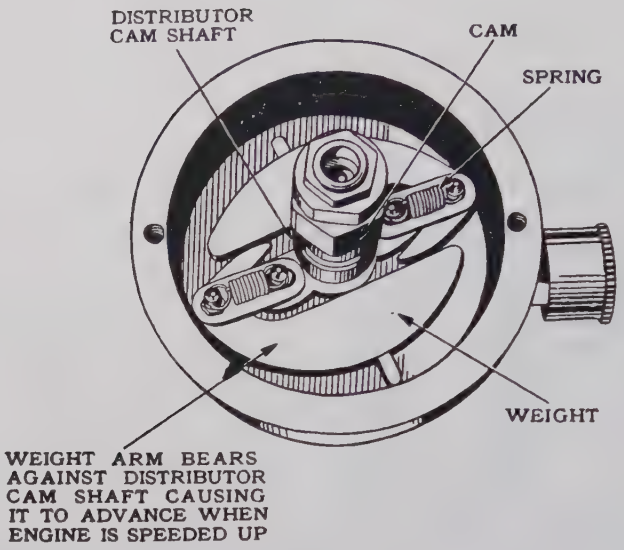


Illus. No. 3
Sectional View of Remy Distributor

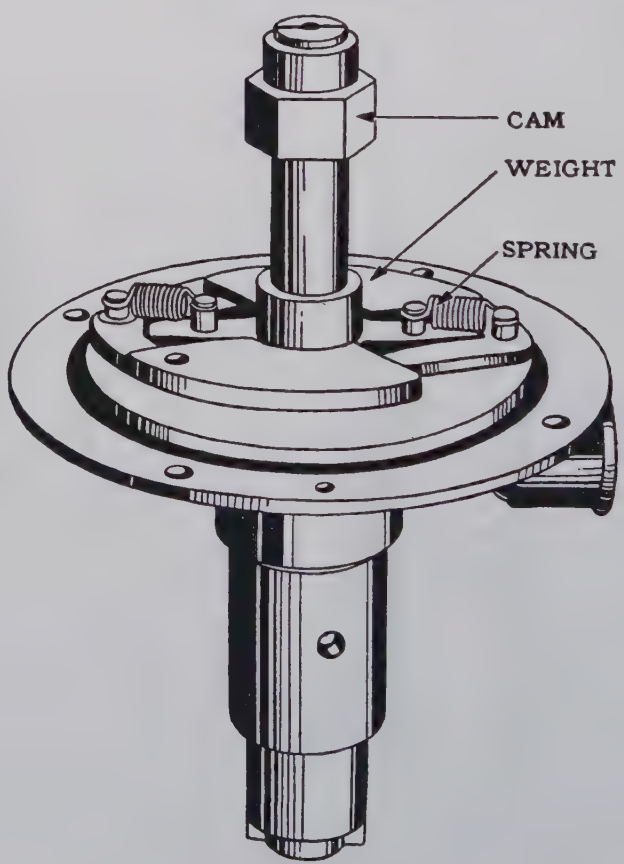




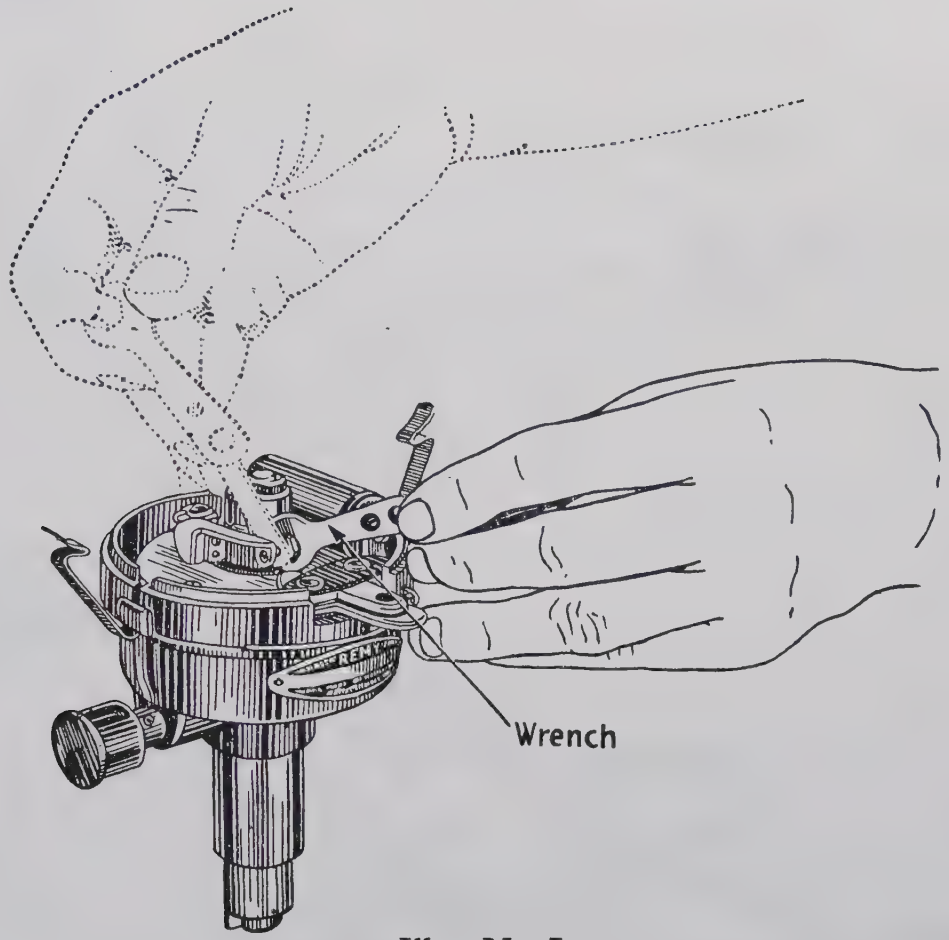
Illus. No. 4
Sectional View of Wagner Distributor


DISTRIBUTOR CAM SHAFT
CAM
SPRING
WEIGHT
WEIGHT ARM BEARS AGAINST DISTRIBUTOR CAM SHAFT CAUSING IT TO ADVANCE WHEN ENGINE IS SPEEDED UP

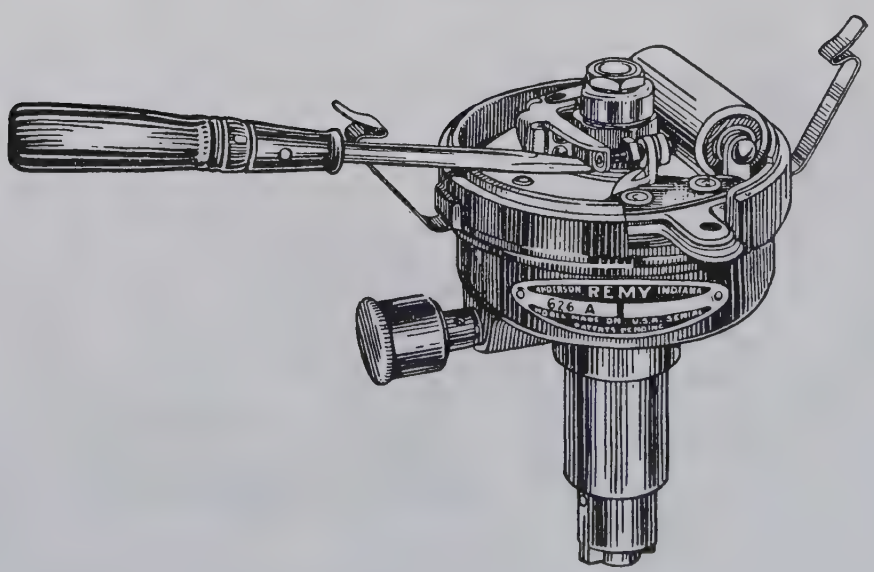
Illus. No. 5
Remy Distributor Automatic Advance Mechanism



Illus. No. 6
Wagner Distributor Automatic Advance Mechanism



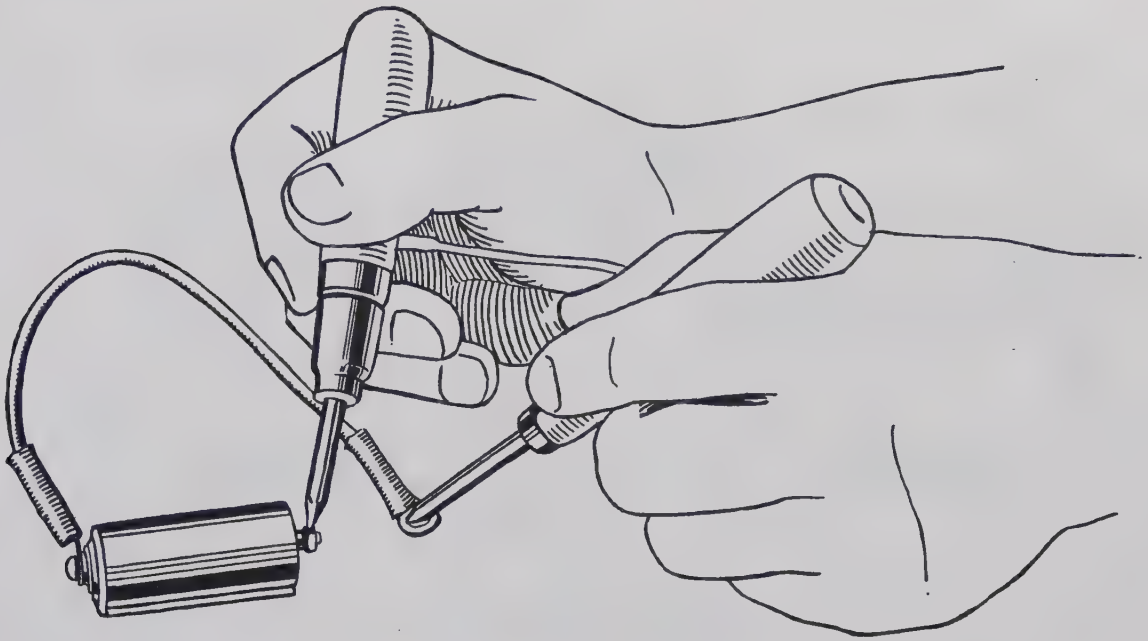
Illus. No. 7
Adjusting Breaker Points



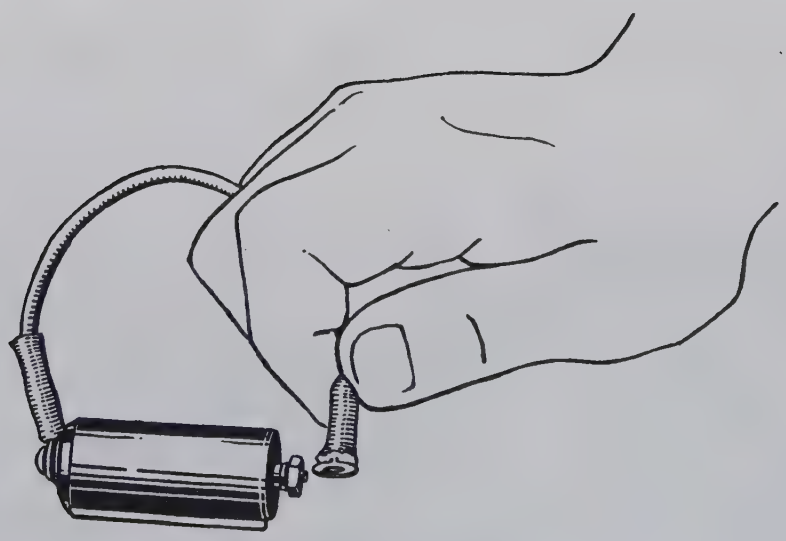
Illus. No. 8
Lifting Distributor Timer Cam

Illus. No. 10
Checking Distributor Gears for Proper Backlash (Big and Special Six)

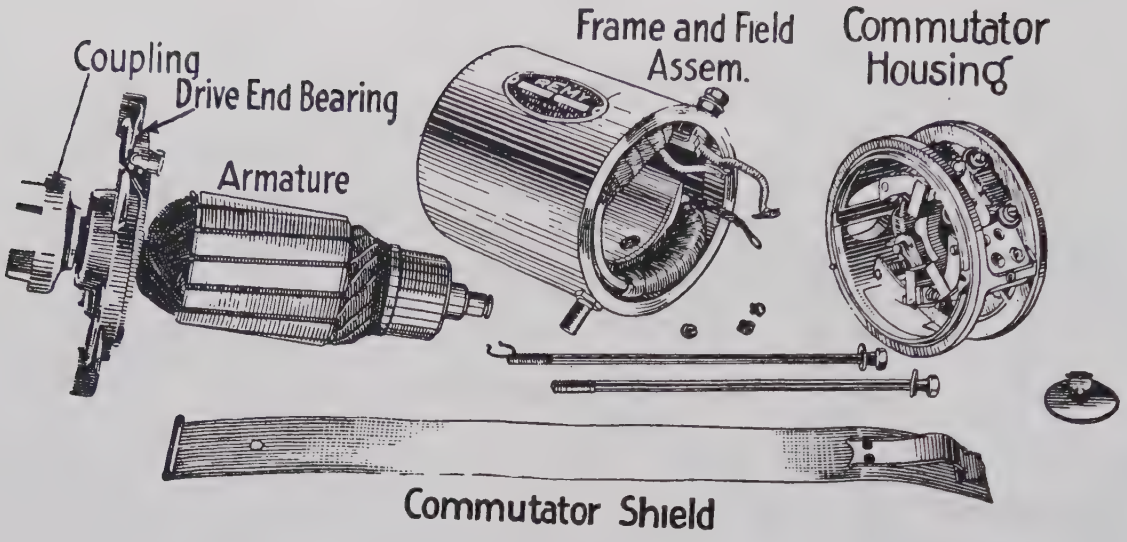
Illus. No. 9
Starting Motor, Generator and Distributor Assembled to Engine (Big and Special Six)



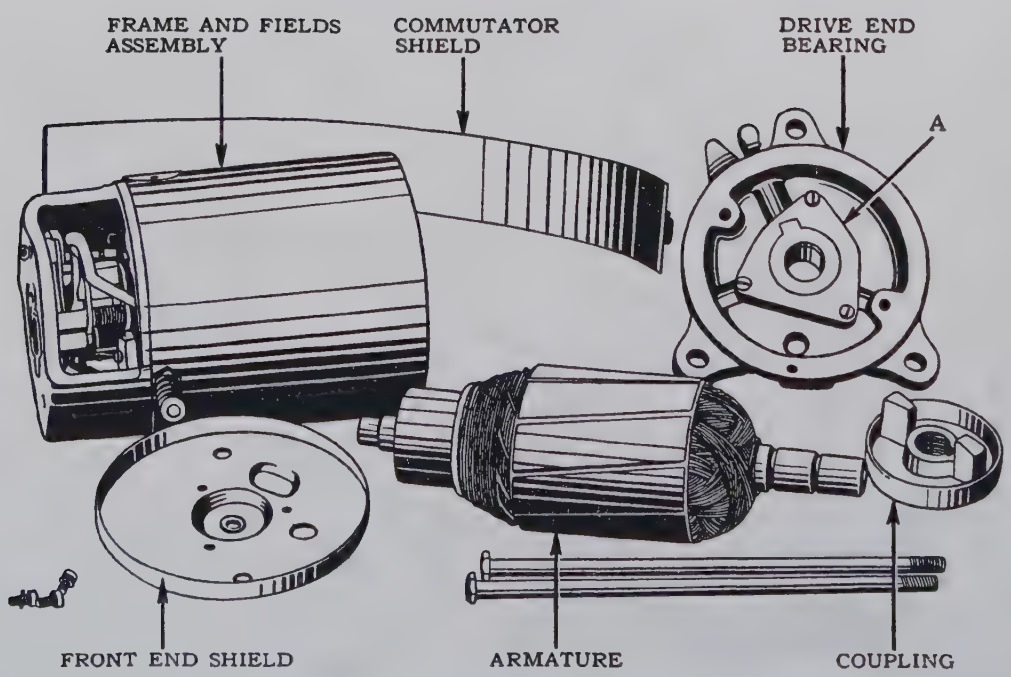
Illus. No. 11
Testing Condenser



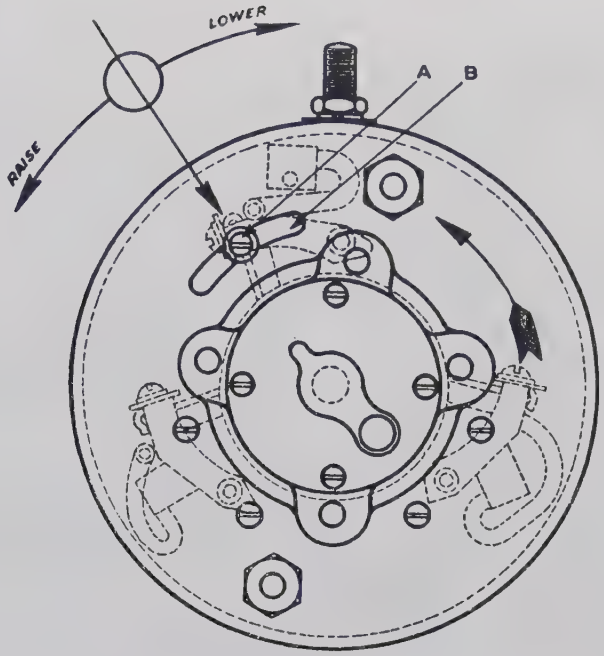
Illus. No. 12
Condenser Capacity Test



Illus. No. 13
Remy Generator—Disassembled
(Big and Special Six)

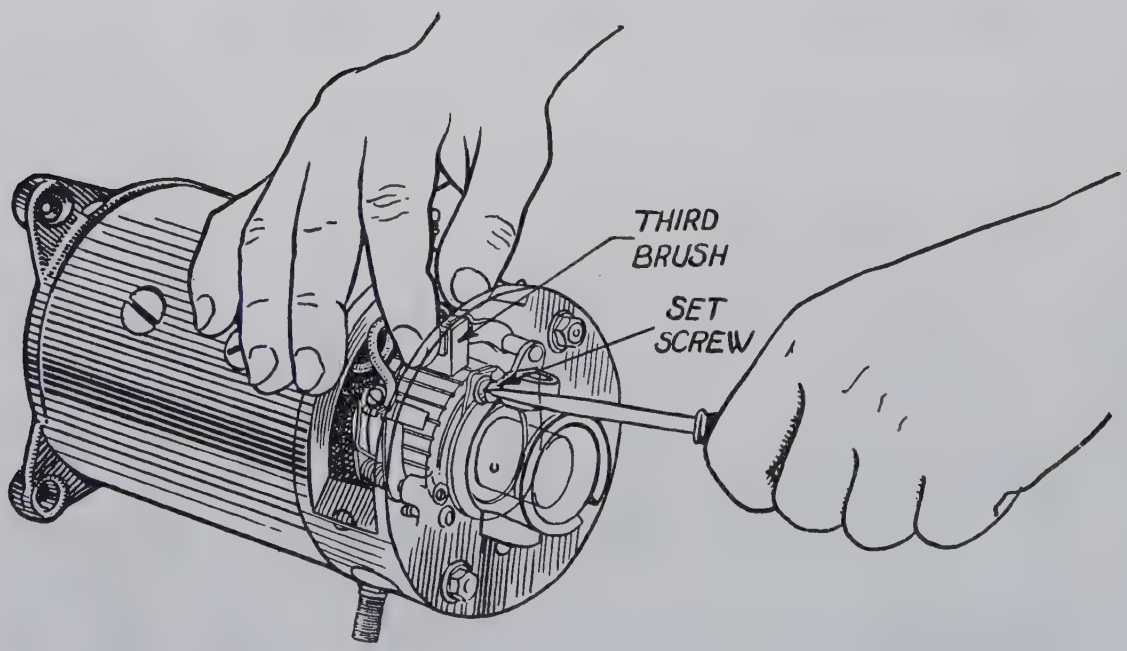


Illus. No. 14
Wagner Generator—Disassembled
(Big and Special Six)



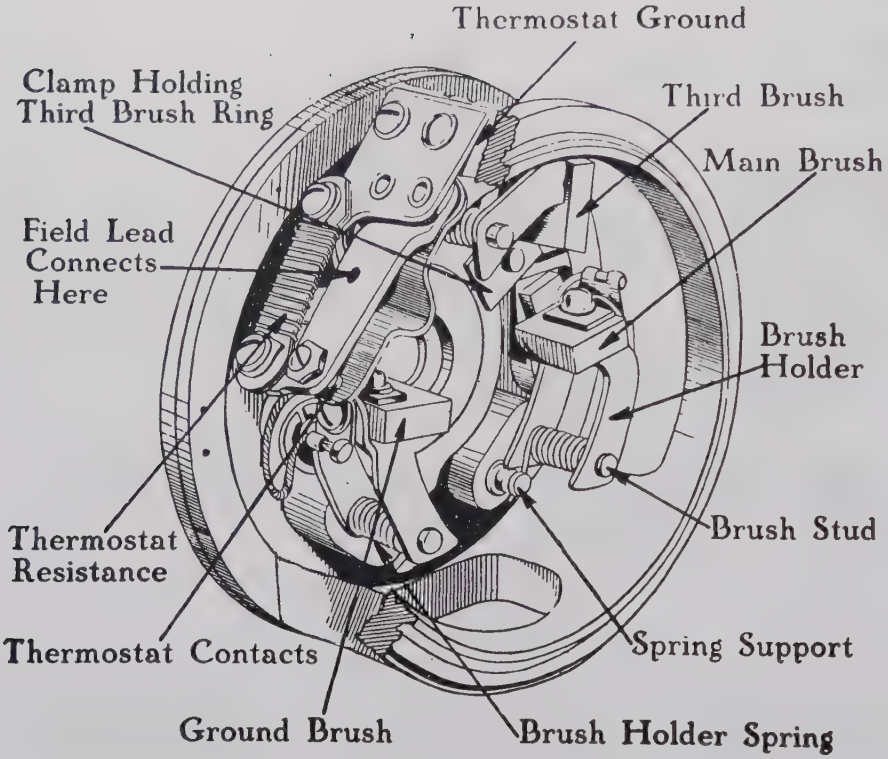
Illus. No. 15

Wagner Third Brush Adjustment. Showing Third Brush Clamping Screw "A" and Direction to Move Brush in Raising or Lowering Charging Rate

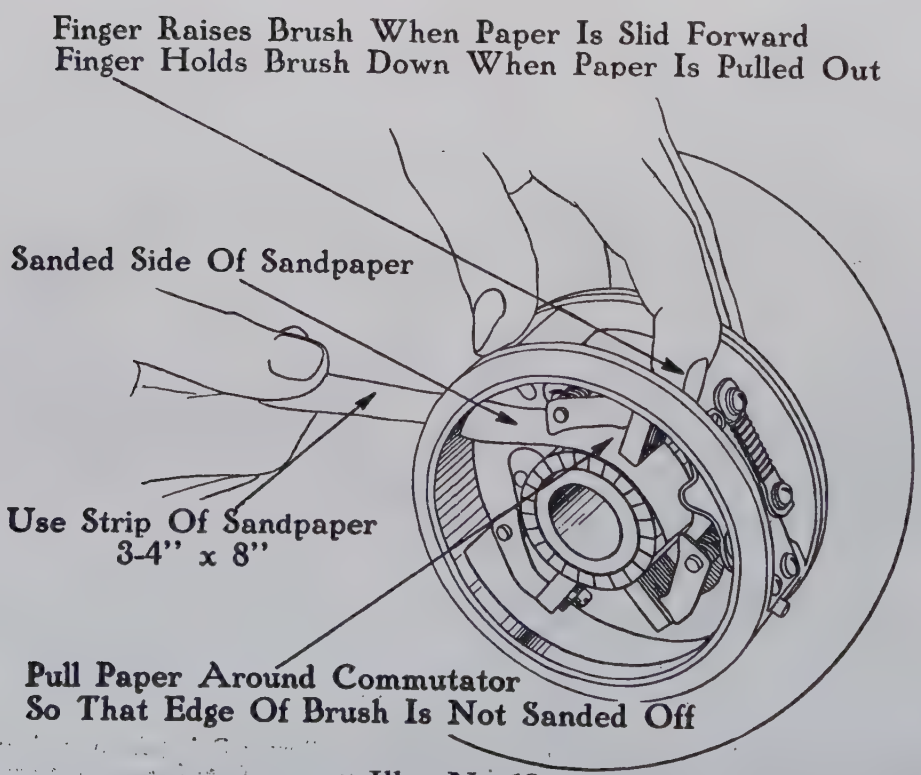


Illus. No. 16

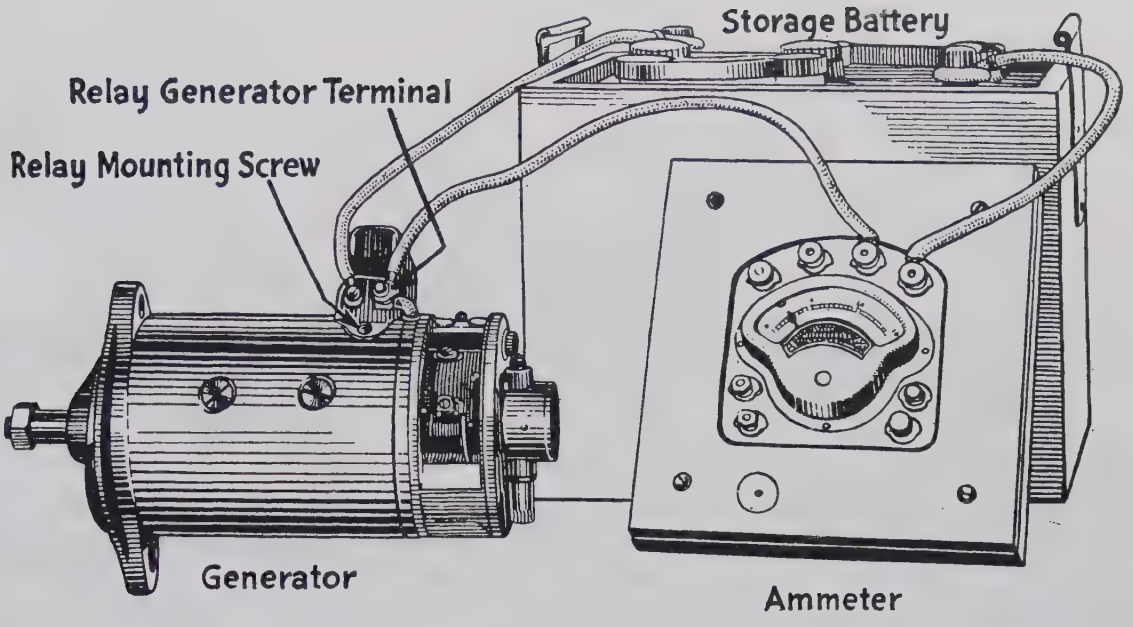
Remy Third Brush Adjustment. Showing Set Screw Being Loosened and Brush Being Moved (In Direction of Commutator Rotation to Increase Current and Against Rotation to Decrease Current)



Illus. No. 17
Remy Brush Mechanism

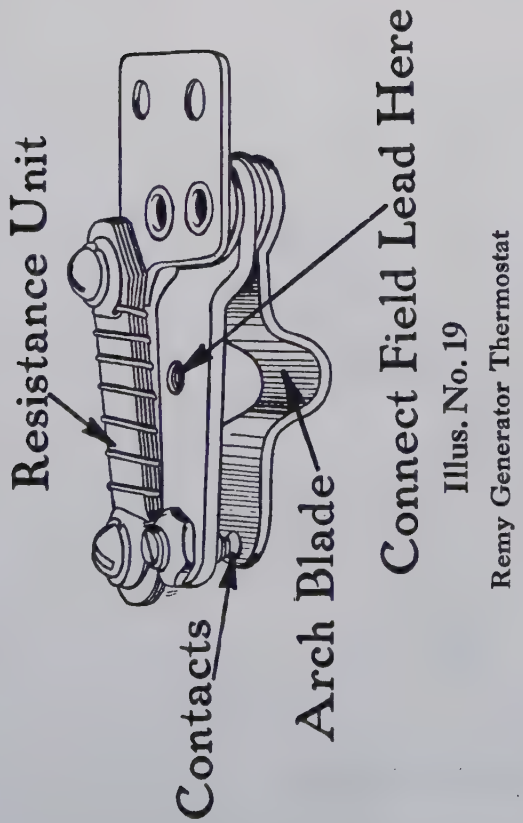

Finger Raises Brush When Paper Is Slid Forward
Finger Holds Brush Down When Paper Is Pulled Out
Sanded Side Of Sandpaper
Use Strip Of Sandpaper
3-4" x 8"
Pull Paper Around Commutator
So That Edge Of Brush Is Not Sanded Off

Illus. No. 18
Proper Method of Sanding Brushes



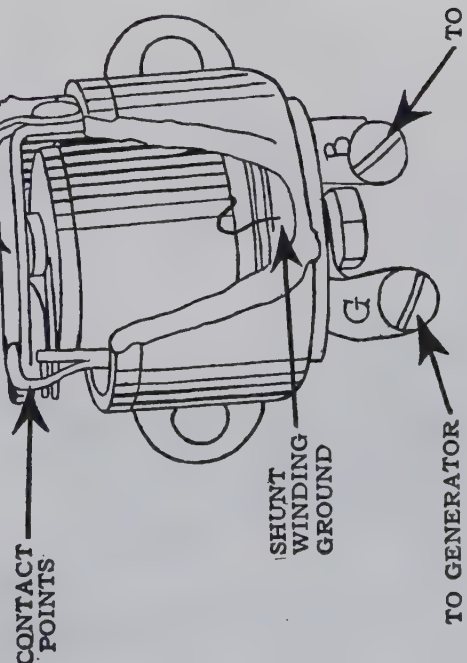
Illus. No. 20

Generator Test for Shorted and Open Circuited Armature. Battery, Generator and Ammeter Are Connected in Series



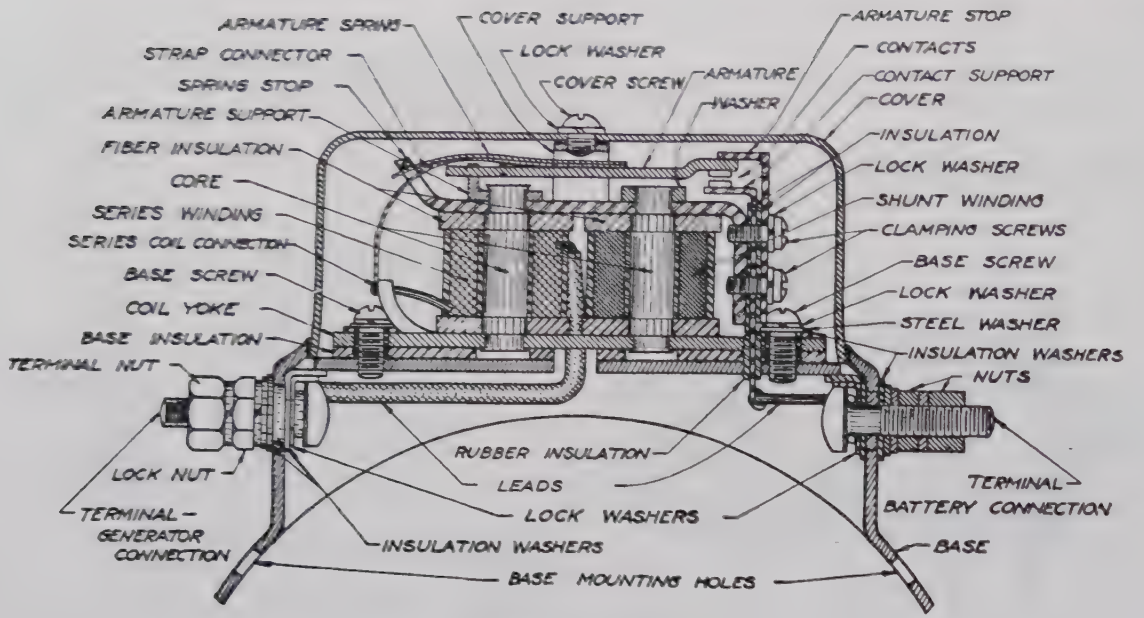
Illus. No. 19

Remy Generator Thermostat

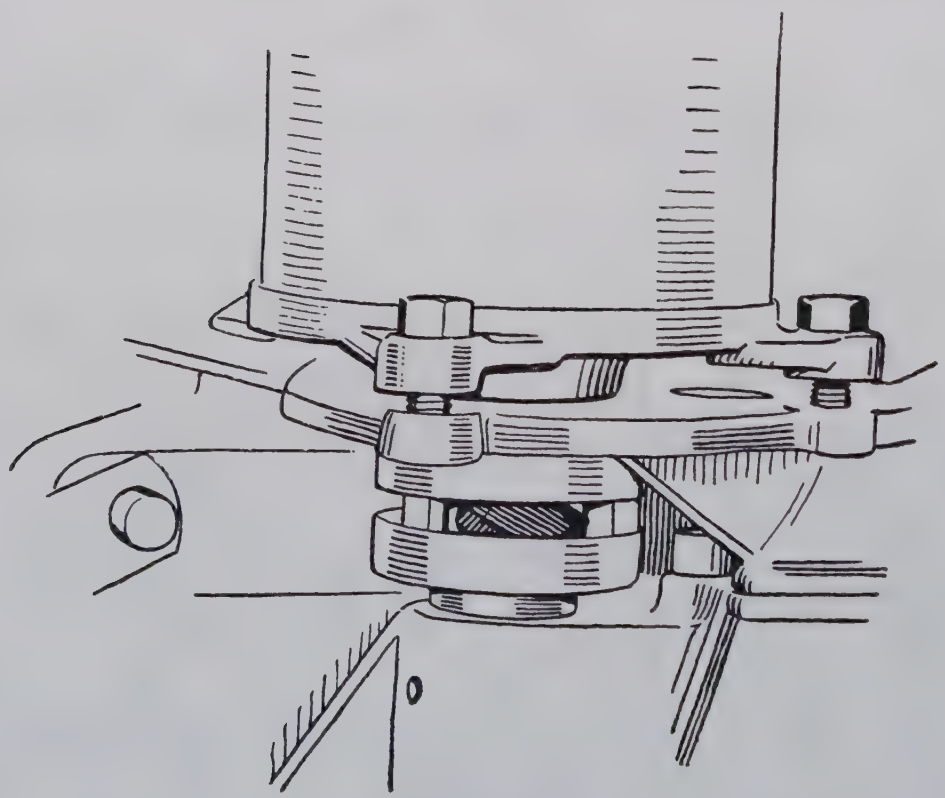


Illus. No. 21

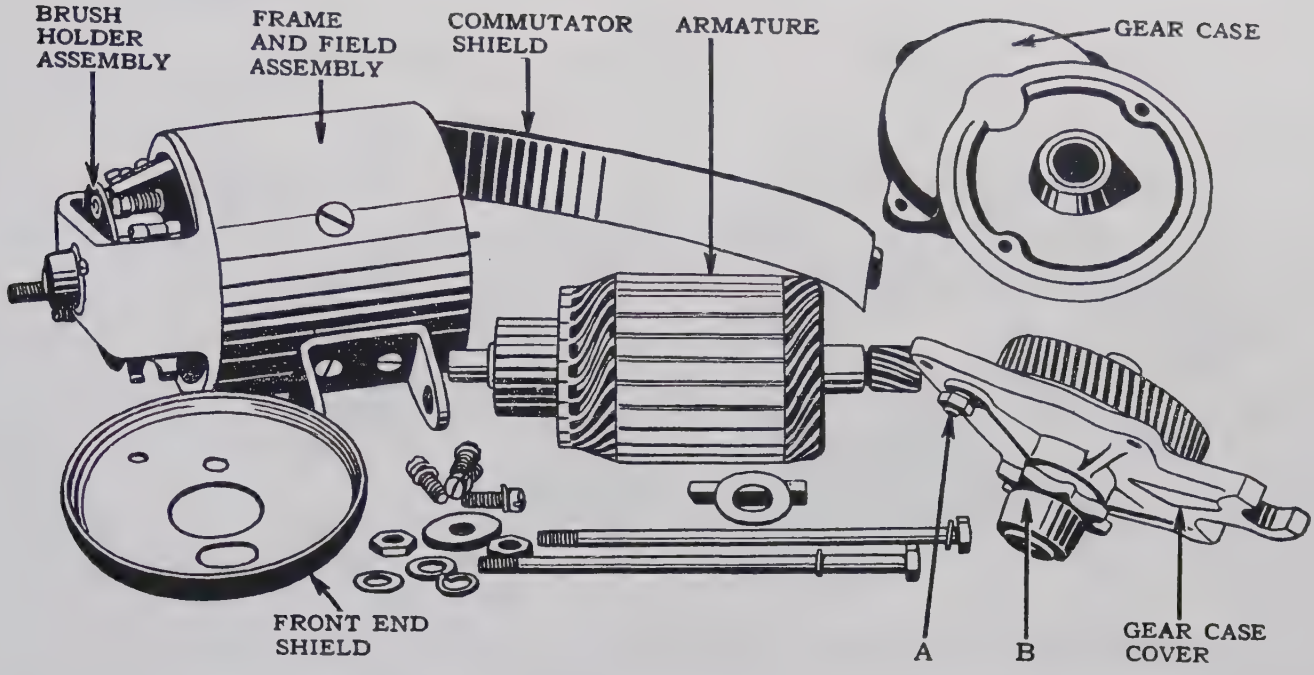
Sectional View of Wagner Relay



Illus. No. 22
Sectional View of Remy Relay
(Standard Six)

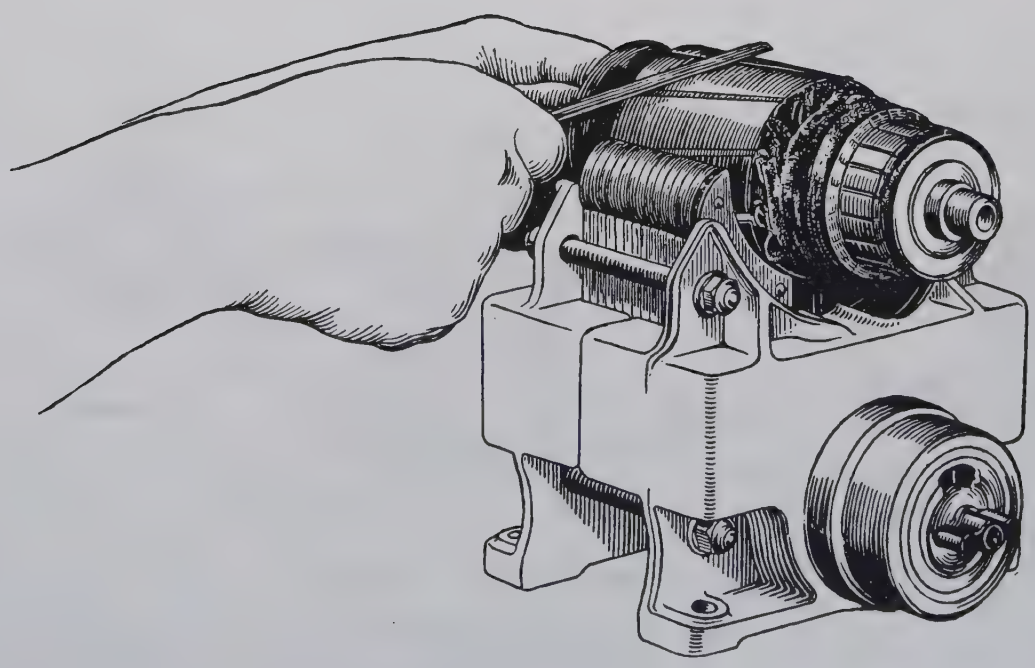


Illus. No. 23
Generator Coupling Rubber Bumpers Improperly Assembled
(Big and Special Six)



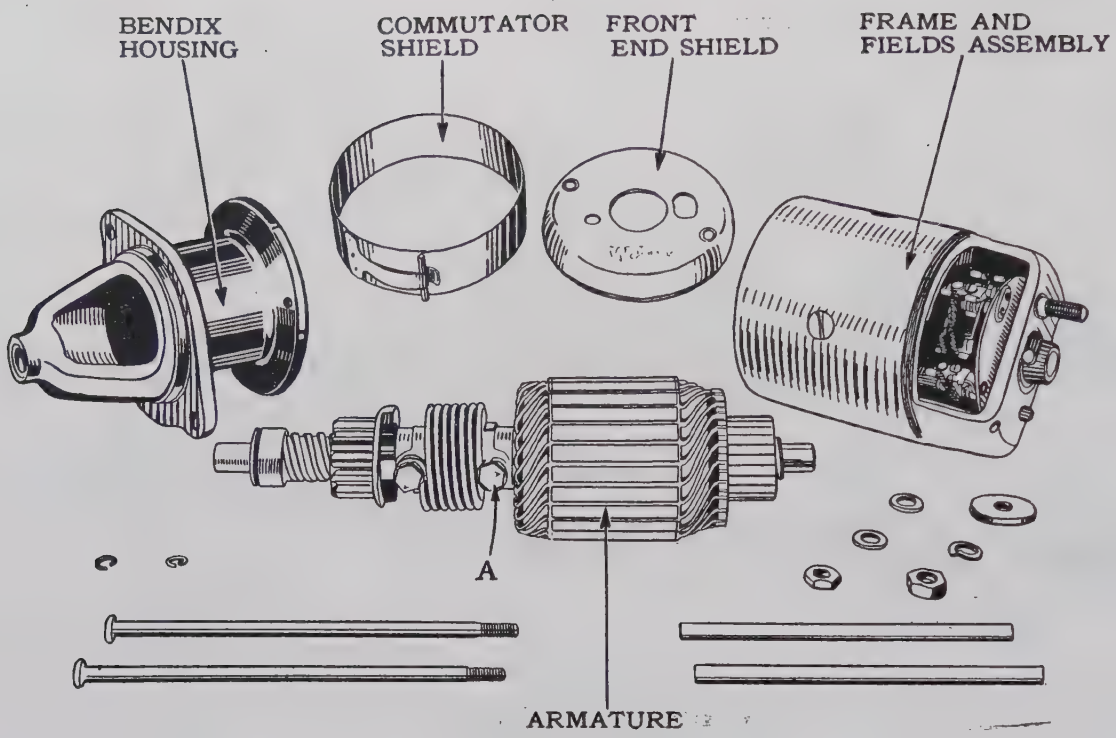
Illus. No. 24

Wagner Starter—Disassembled
(Big and Special Six)



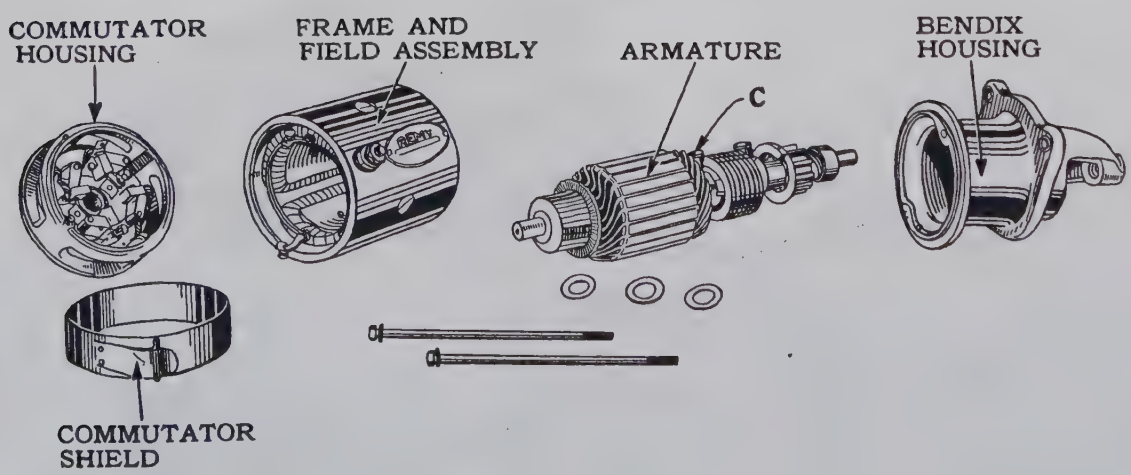
Illus. No. 25

Testing Armature With Growler



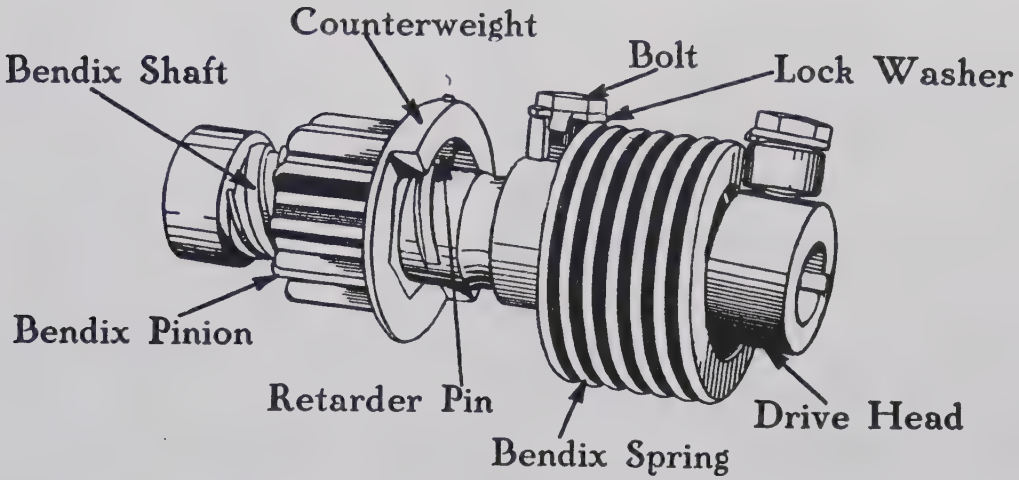
Illus. No. 26

Wagner Starter—Disassembled (Standard Six)



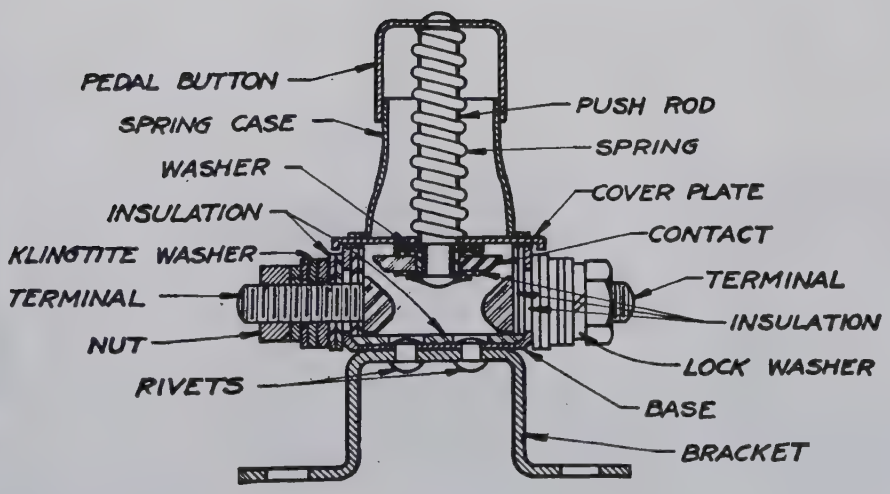
Illus. No. 27

Remy Starter—Disassembled (Standard Six)



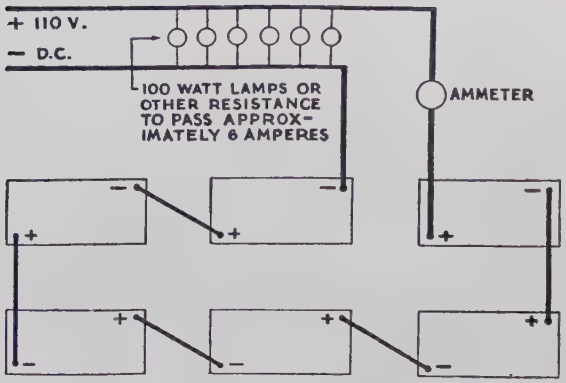
Illus. No. 28

Bendix Drive
(Standard Six)

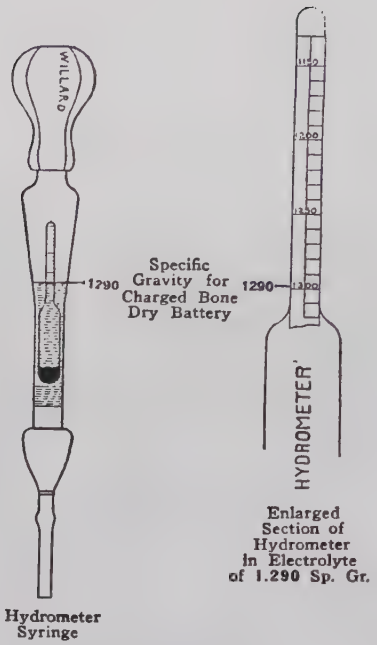


Illus. No. 29

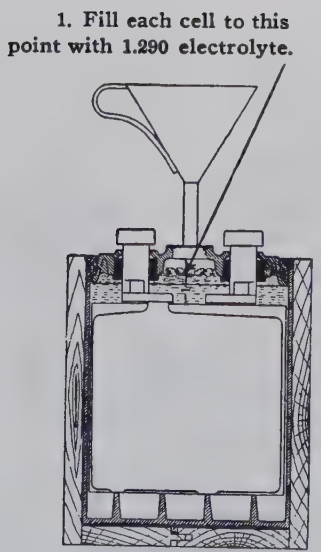
Sectional View, Starter Switch



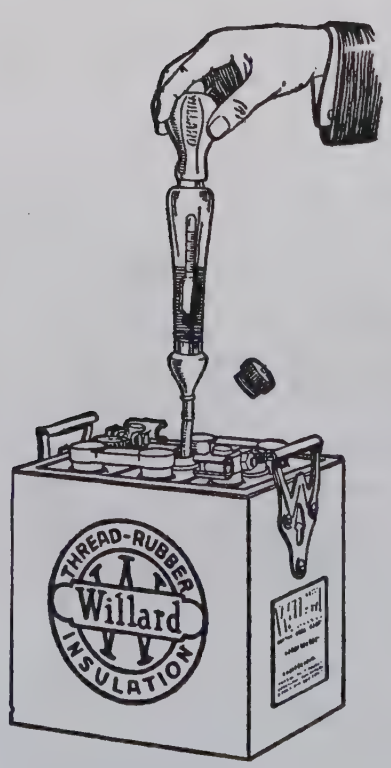
Illus. No. 30
Battery Charging Circuit



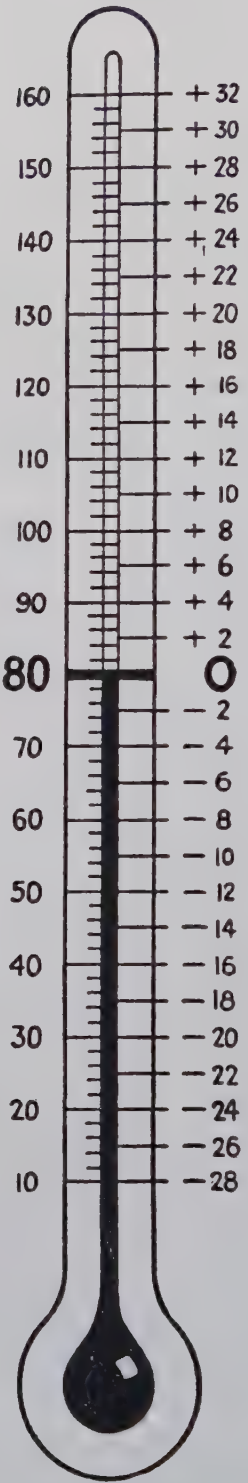
Illus. No. 31
Hydrometer



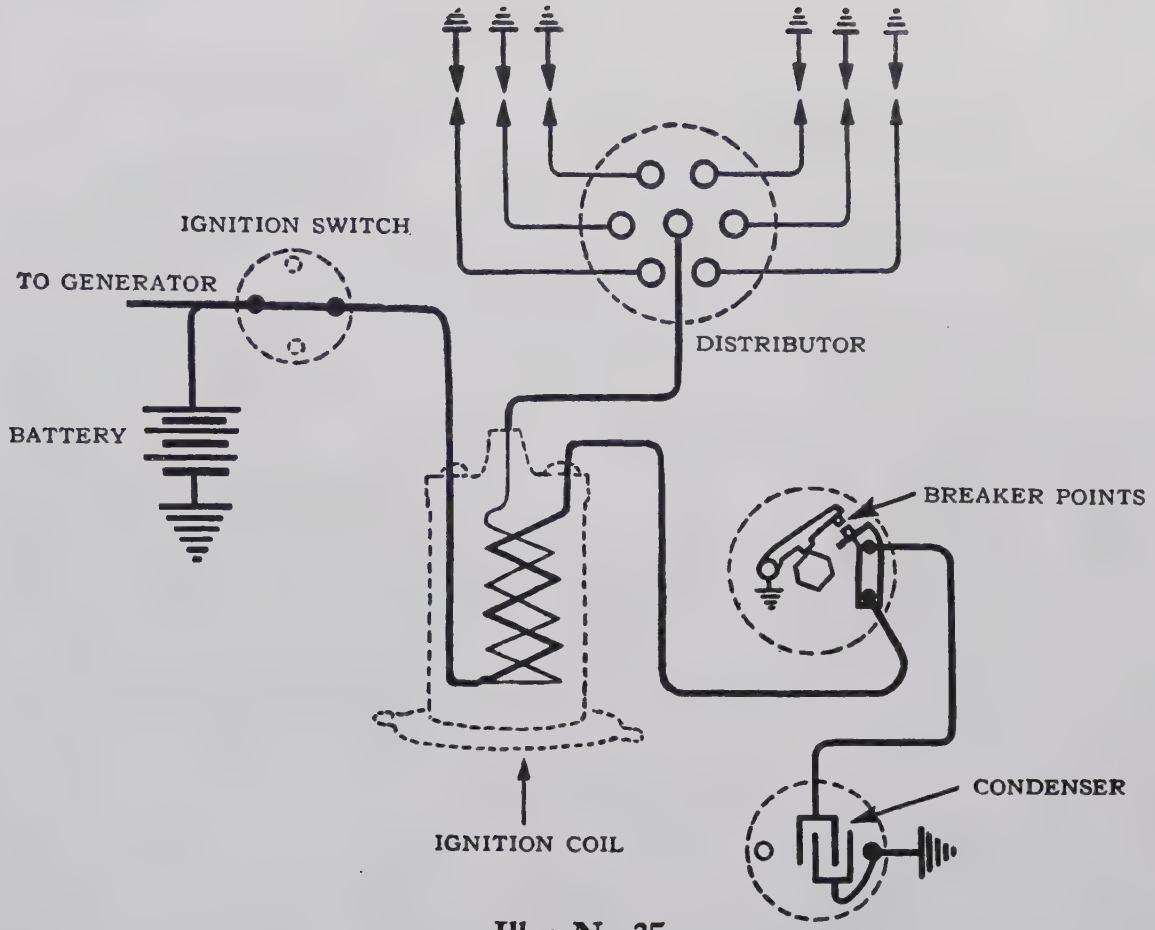
Illus. No. 32
Point to Which Battery Is Filled When First Preparing Charged Bone Dry Battery



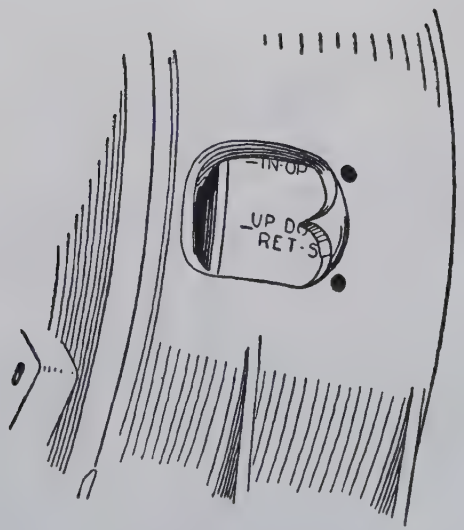
Illus. No. 33
Testing Battery With Hydrometer



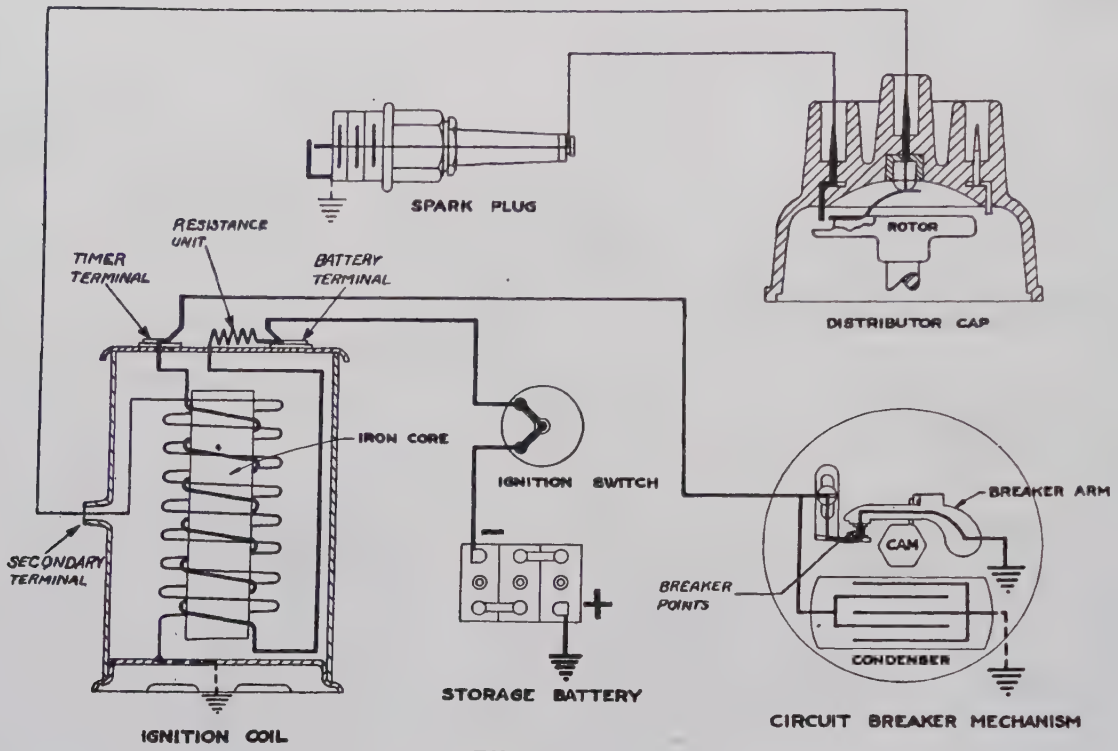
Illus. No. 34
Temperature Corrections to Be Made in Reading The Specific Gravity of the Battery



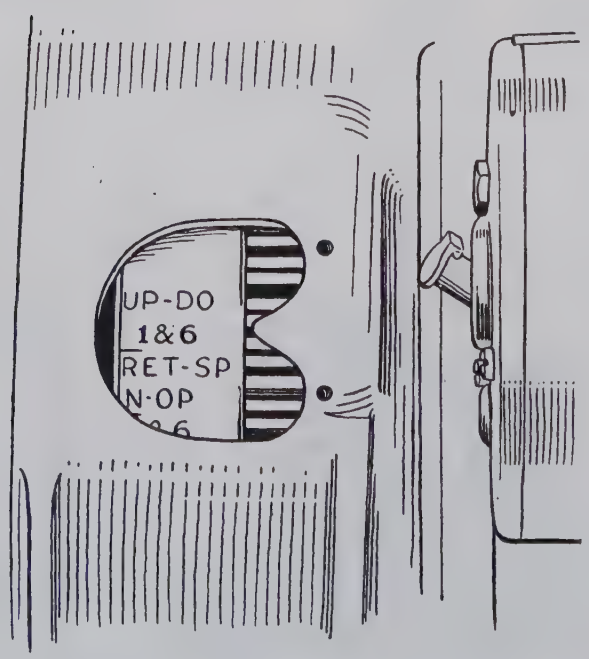
Illus. No. 35
Wagner Ignition Circuit



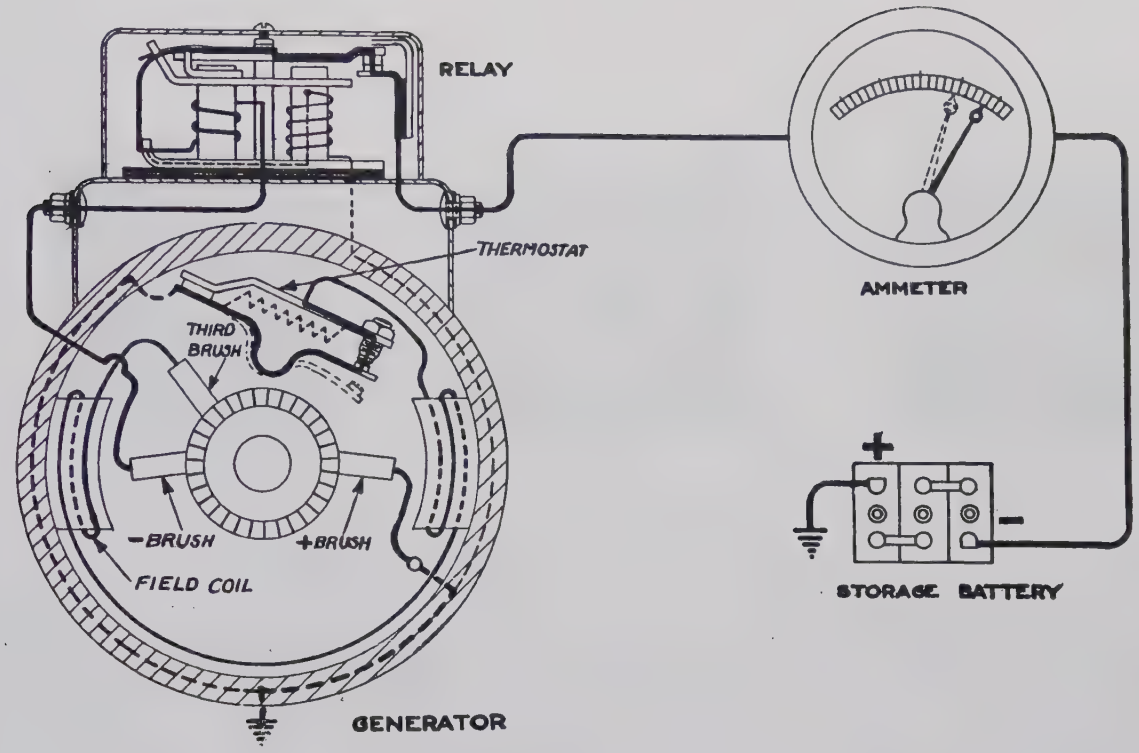
Illus. No. 36
Flywheel Marks and Timing Hole
(Big and Special Six)



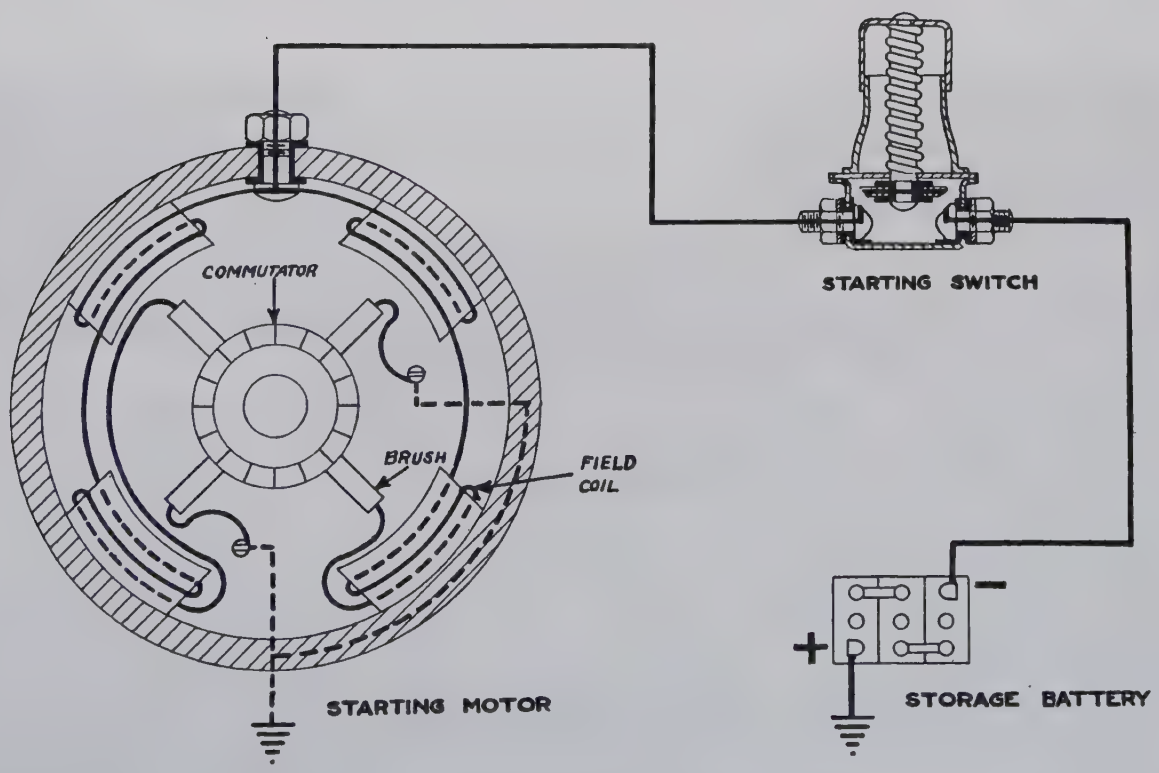
Illus. No. 37
Remy Ignition Circuit



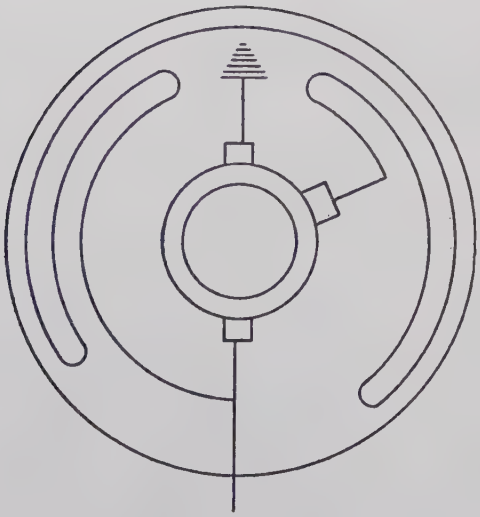
Illus. No. 38
Flywheel Marks and Timing Hole
(Standard Six)



Illus. No. 39
Remy Charging Circuit

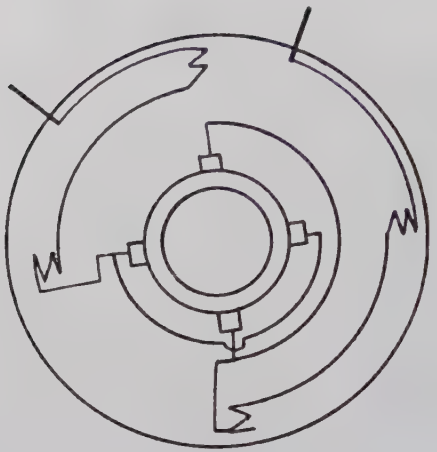


Illus. No. 40
Remy Starting Circuit



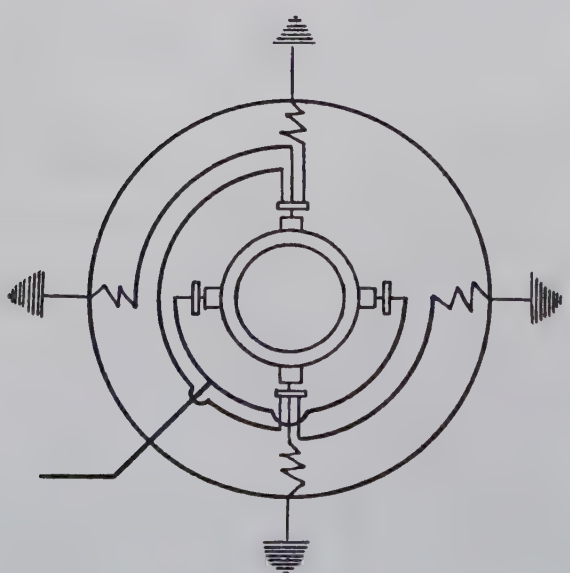
Illus. No. 41

Wagner Generator Internal Wiring Diagram



Illus. No. 42

Wagner Starter Internal Wiring Diagram (Big and Special Six)



Illus. No. 43

Wagner Starter Internal Wiring Diagram (Standard Six)

Fig. 1 Fig. 2 Fig. 3

Illus. No. 44

Focus for Headlamps Having Dimmer Resistance Unit

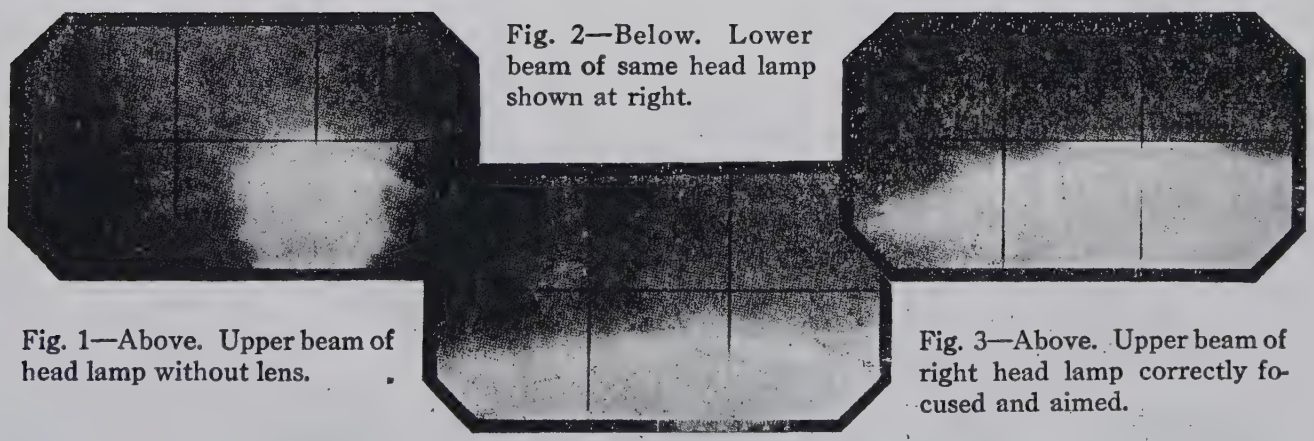


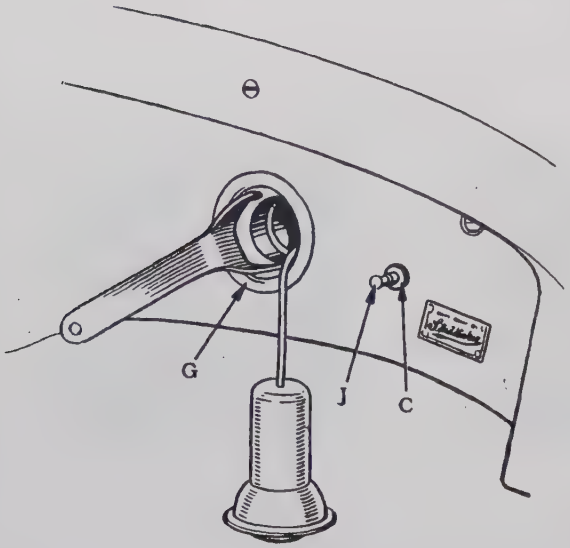
Fig. 1—Above. Upper beam of head lamp without lens.

Fig. 2—Below. Lower beam of same head lamp shown at right.

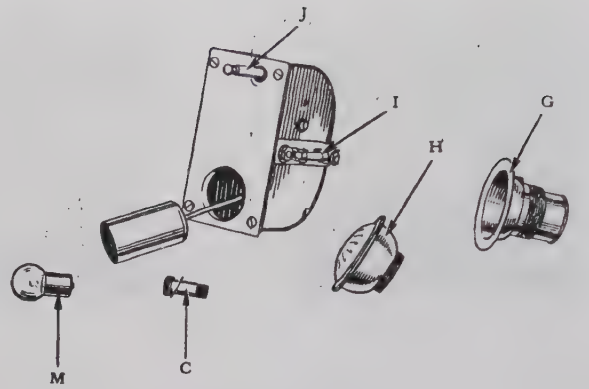
Fig. 3—Above. Upper beam of right head lamp correctly focused and aimed.

Illus. No. 45

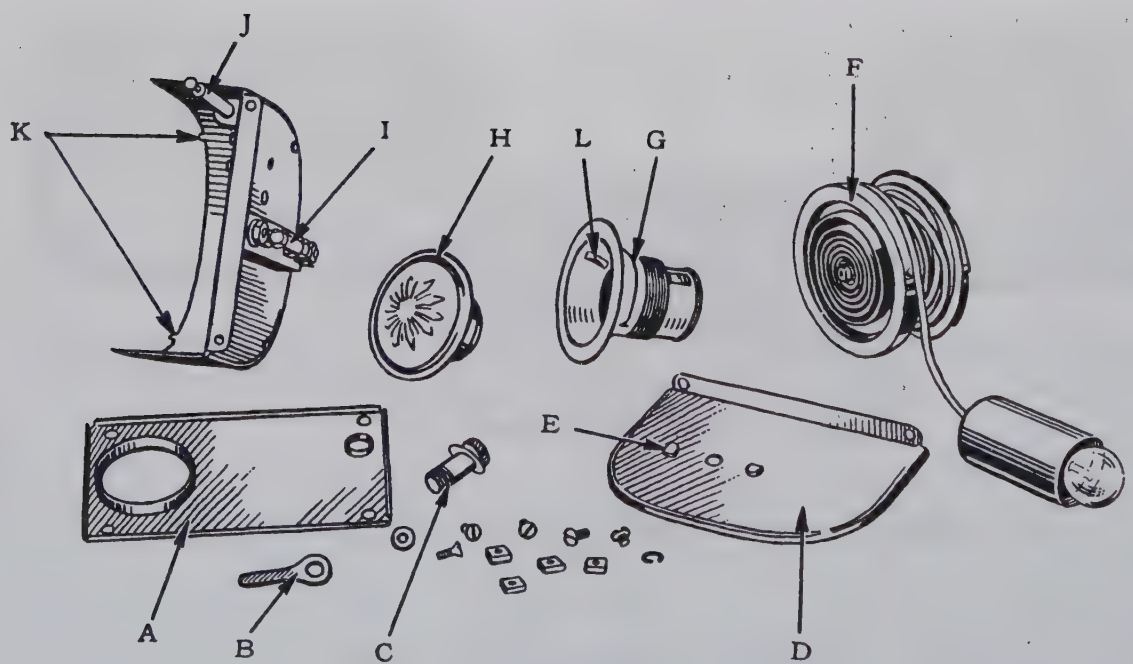
Headlamp Focus for Double Filament Lamps



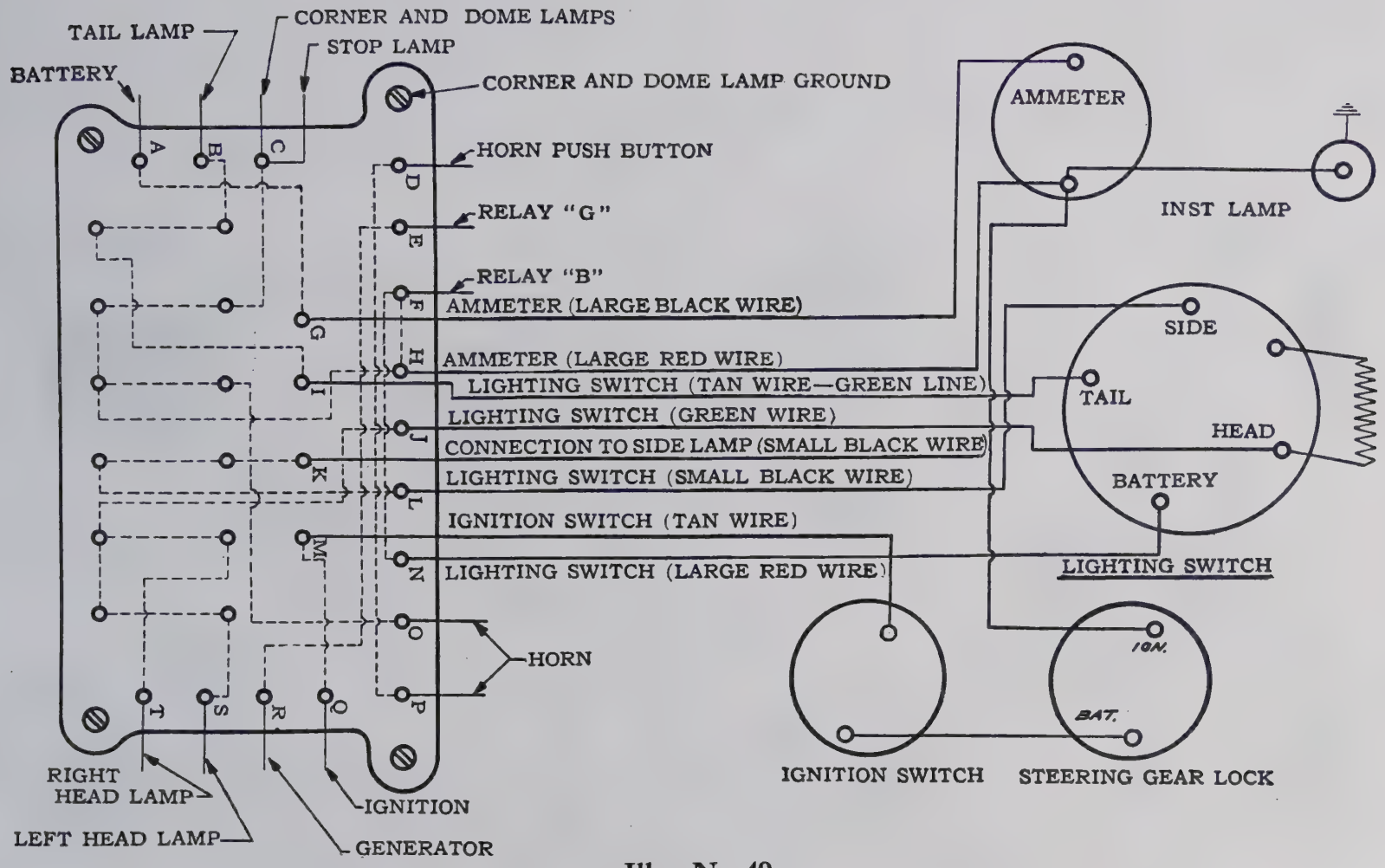
Illus. No. 46
Removing Inspection Lamp



Illus. No. 47
Inspection Lamp Removed

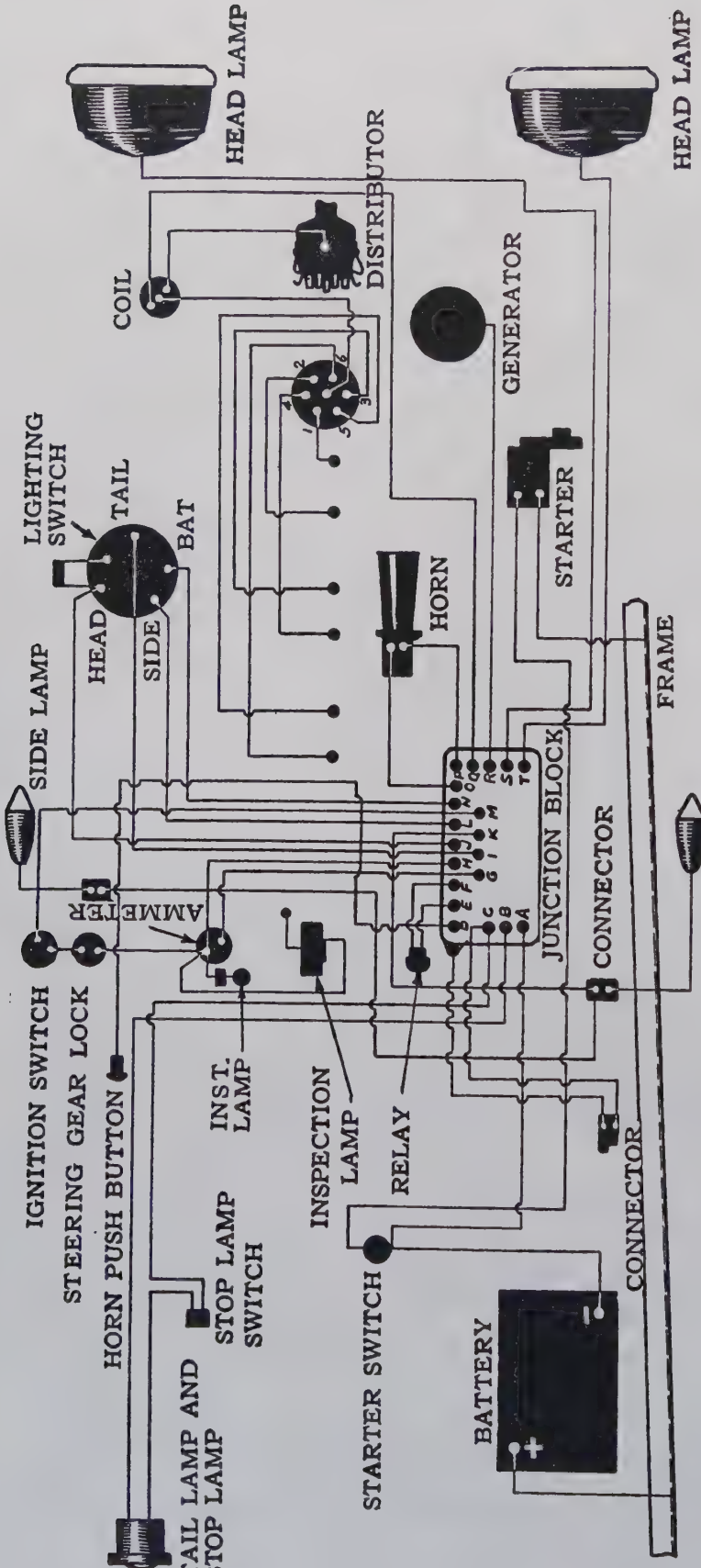


Illus. No. 48
Inspection Lamp—Disassembled



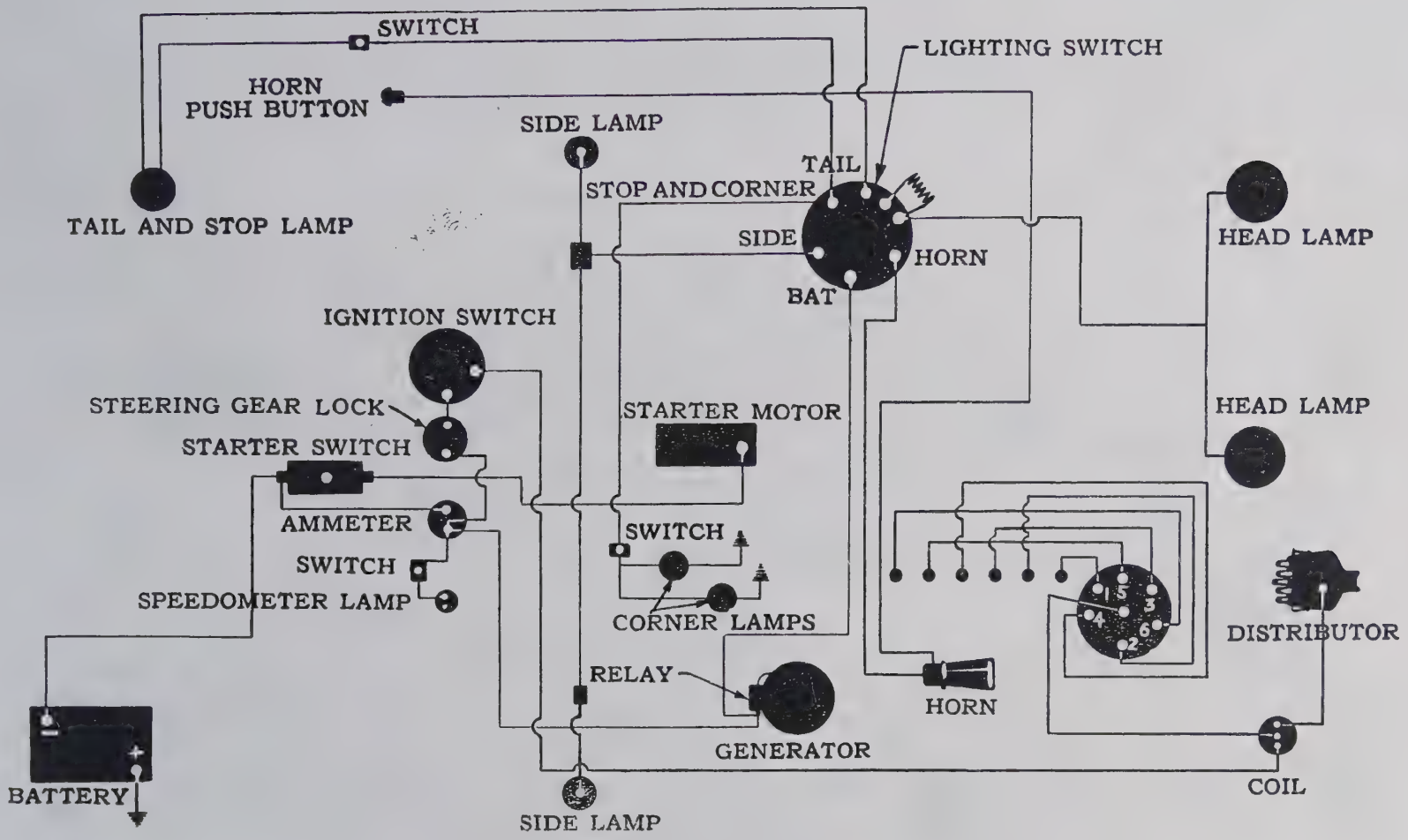
Illus. No. 49

Junction Block Wiring Diagram
(Big and Special Six)



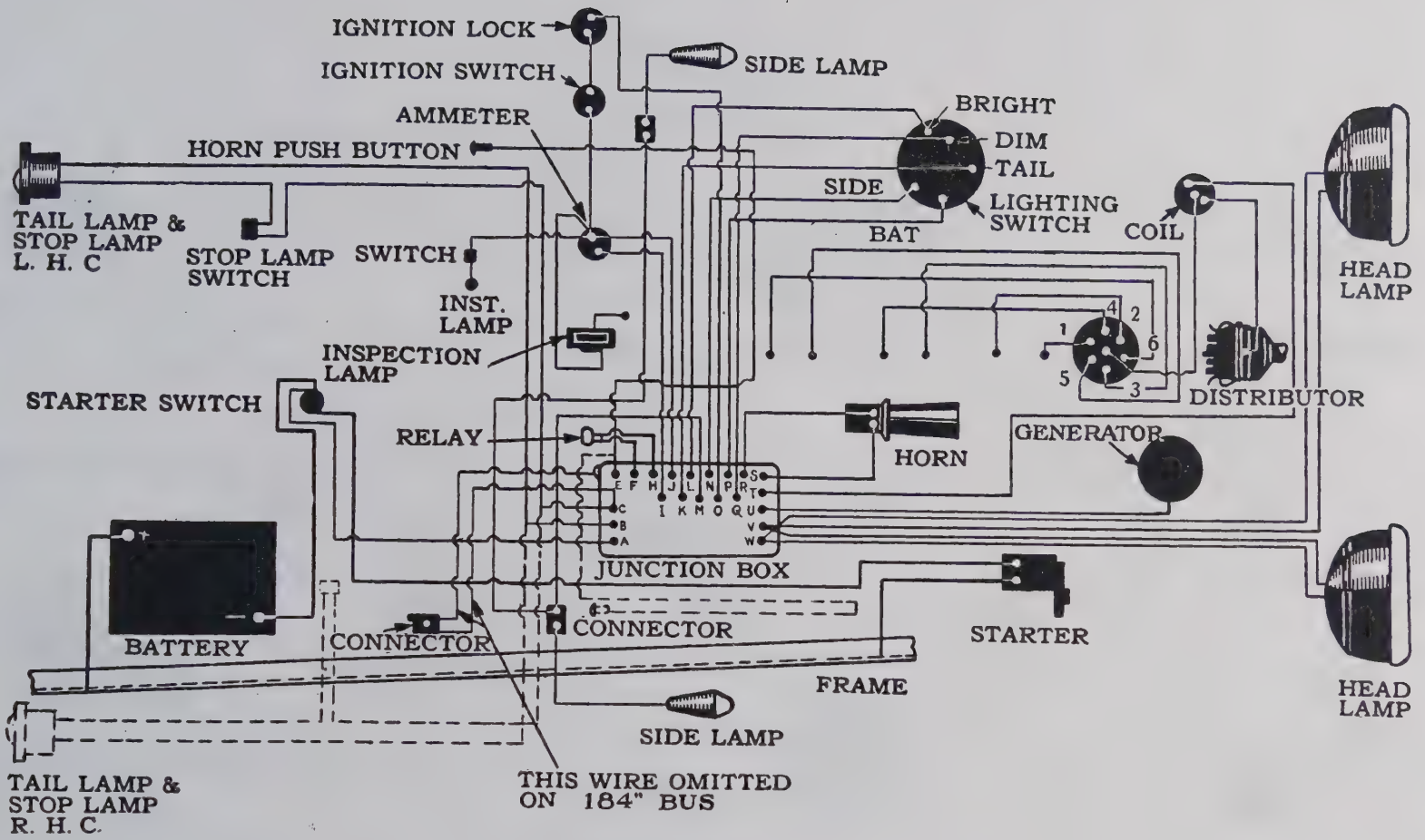
Illus. No. 50

Car Wiring Diagram
(Big and Special Six)



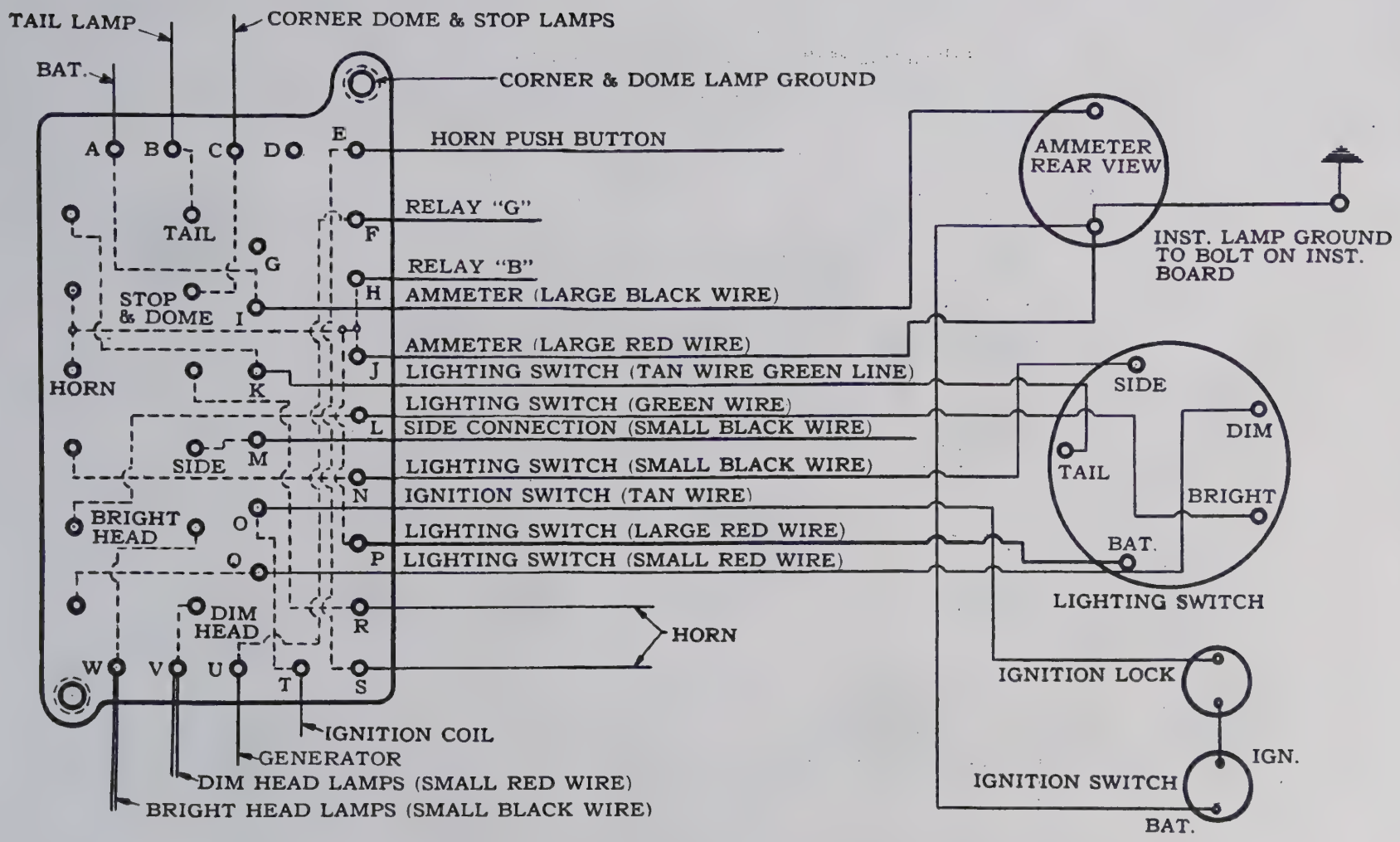
Illus. No. 51

Car Wiring Diagram
(Standard Six)



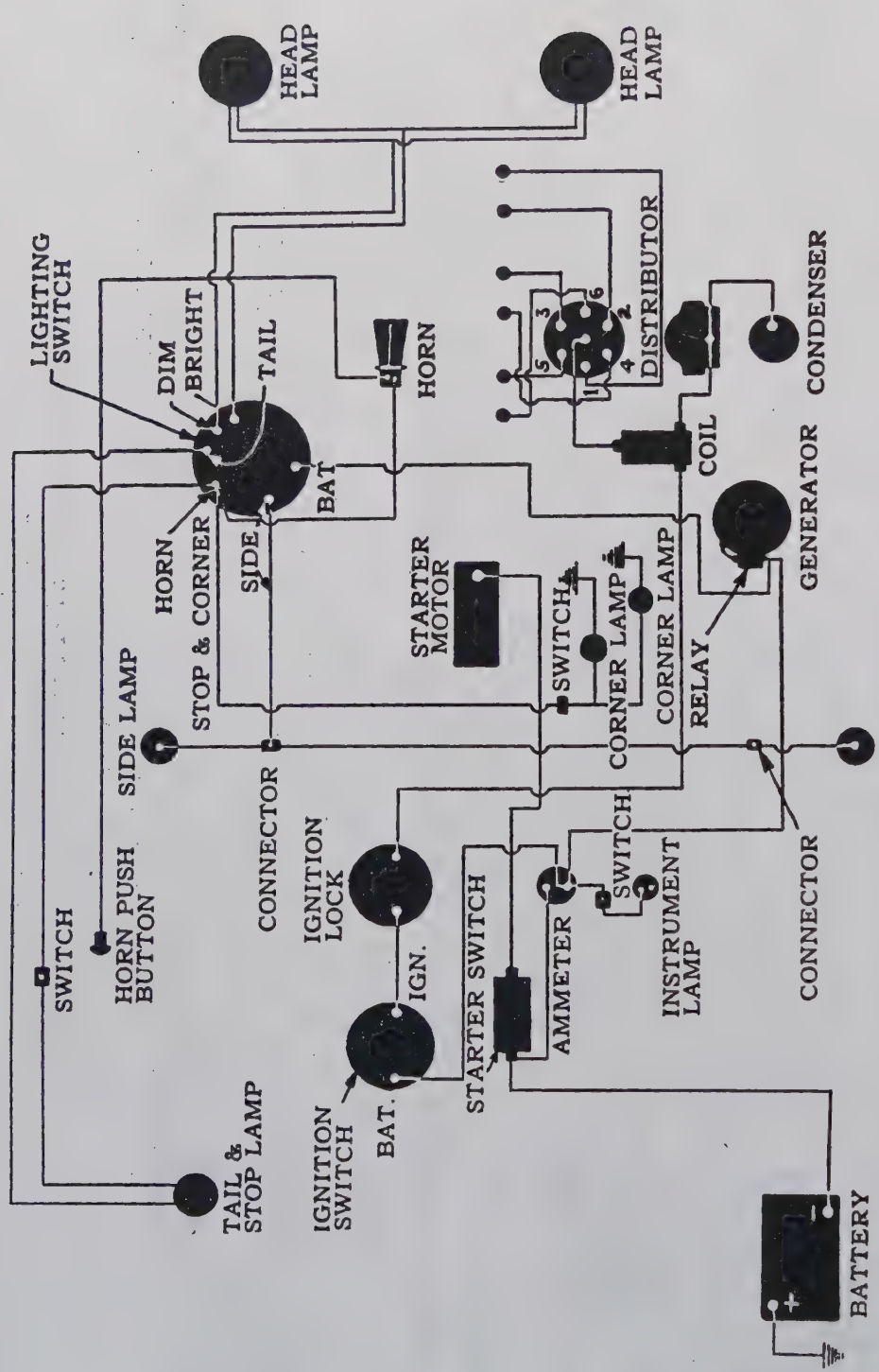
Illus. No. 52

Car Wiring Diagram for Double Filament Headlamps
(Big and Special Six)

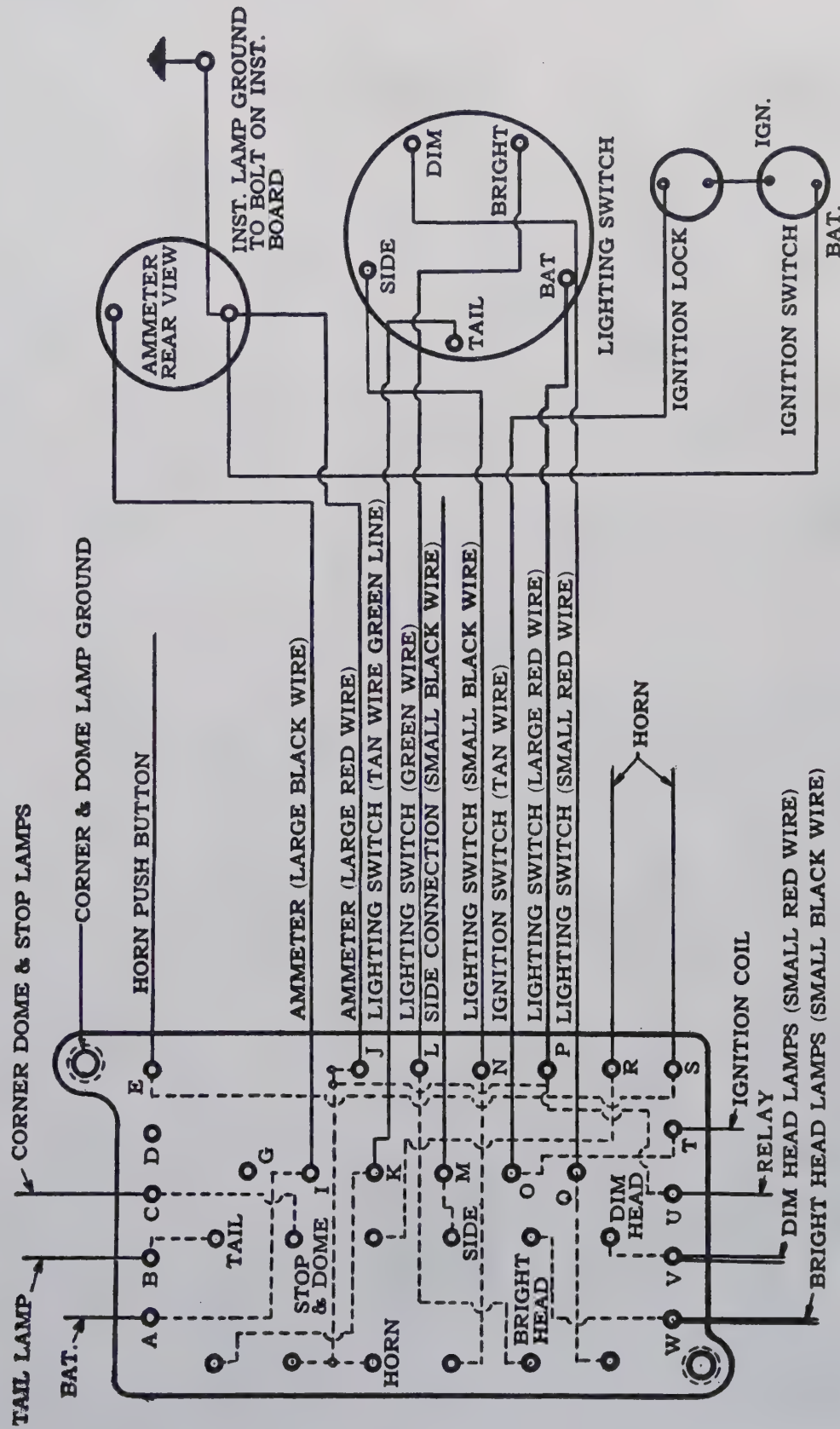


Illus. No. 53

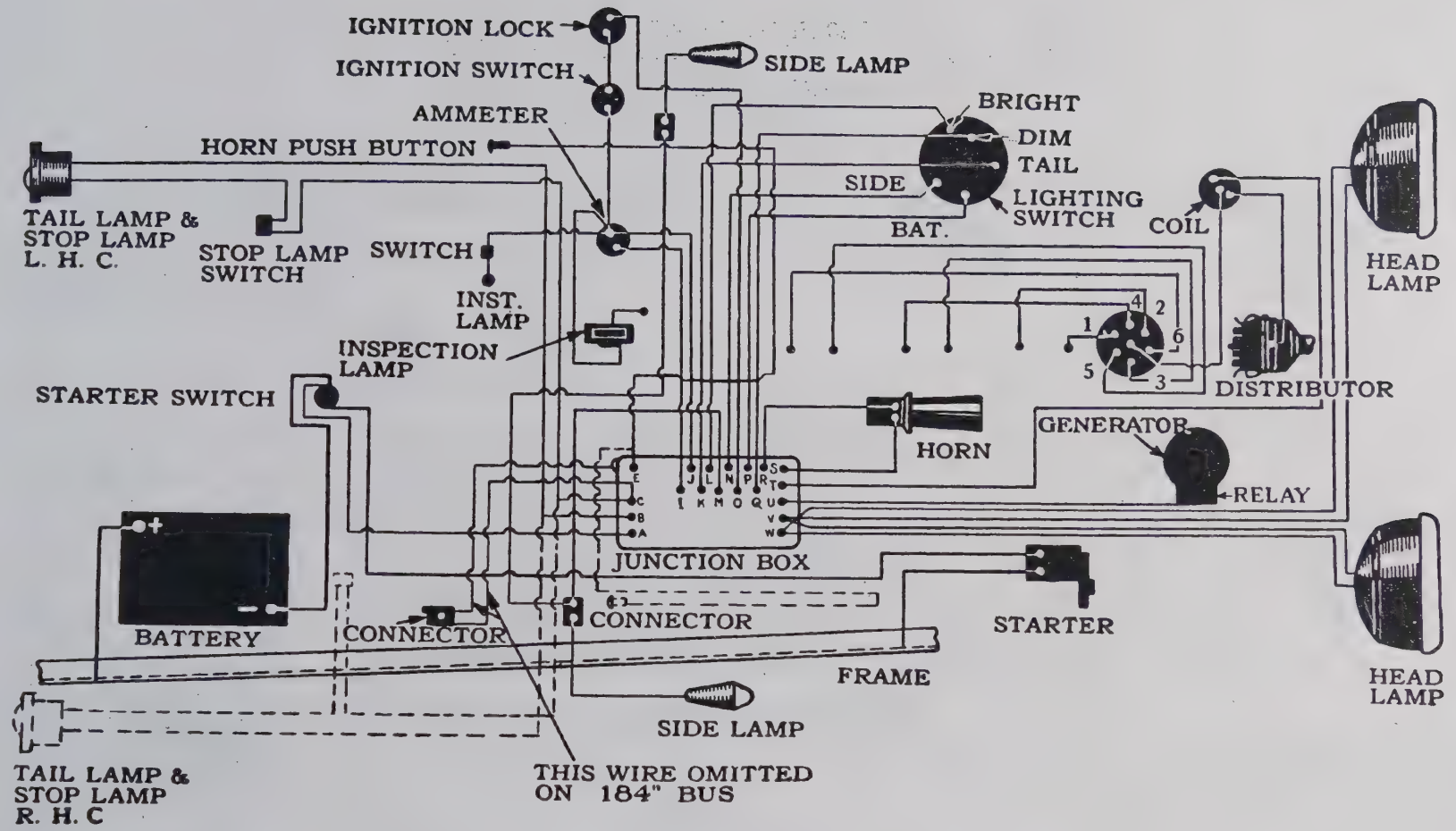
Junction Block Wiring Diagram for Double Filament Headlamps (Big and Special Six)



Illus. No. 54
Car Wiring Diagram for Double Filament Headlamps
(Standard Six)



Illus. No. 55
Junction Block Wiring Diagram—Relay on Generator
(Big and Special Six)



Illus. No. 56

Car Wiring Diagram—Relay on Generator
(Big and Special Six)

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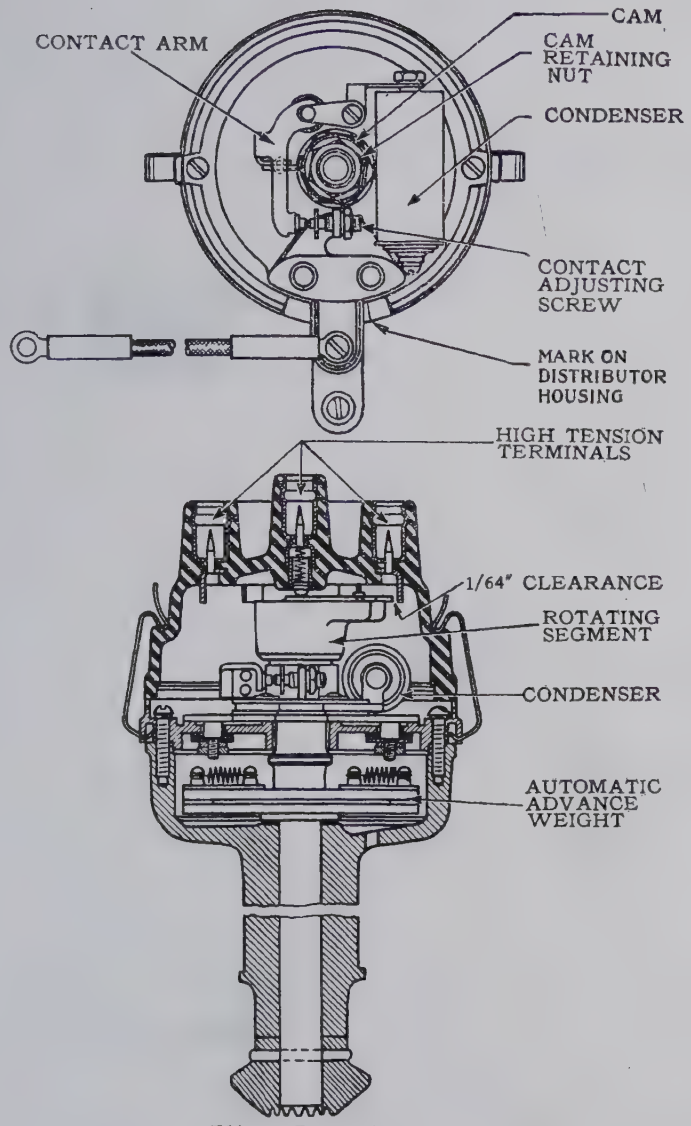
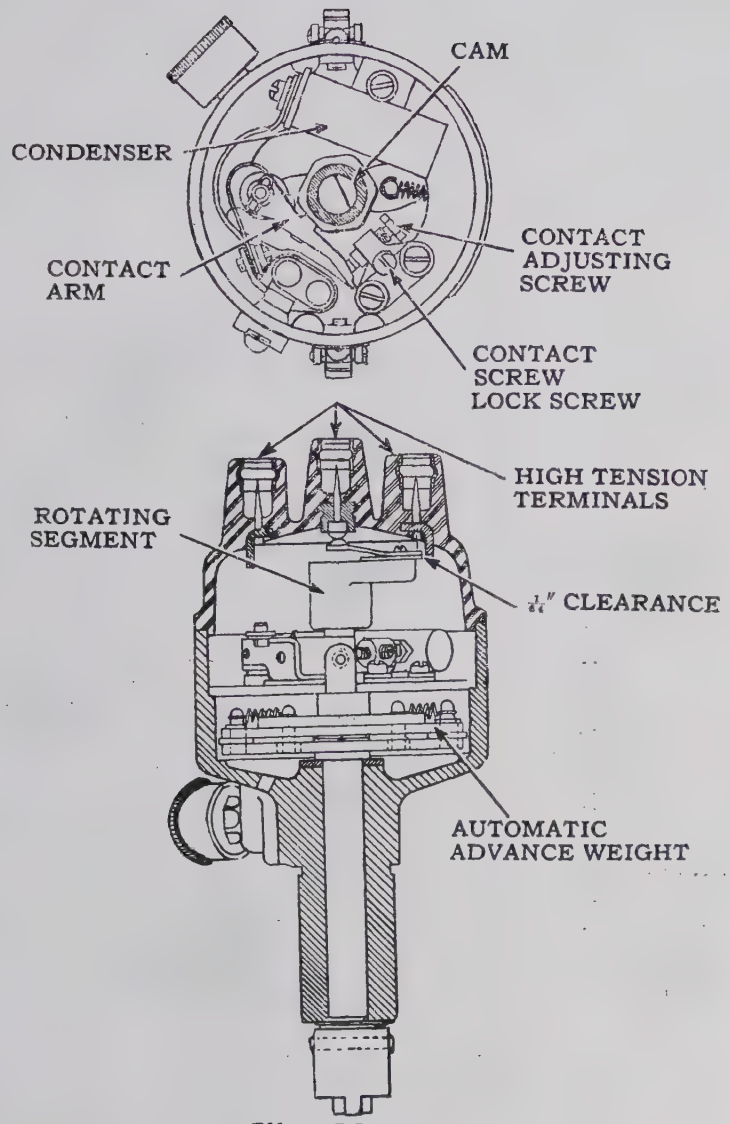
Issued October 15, 1927
Insert in Volume Seven, after page 78.



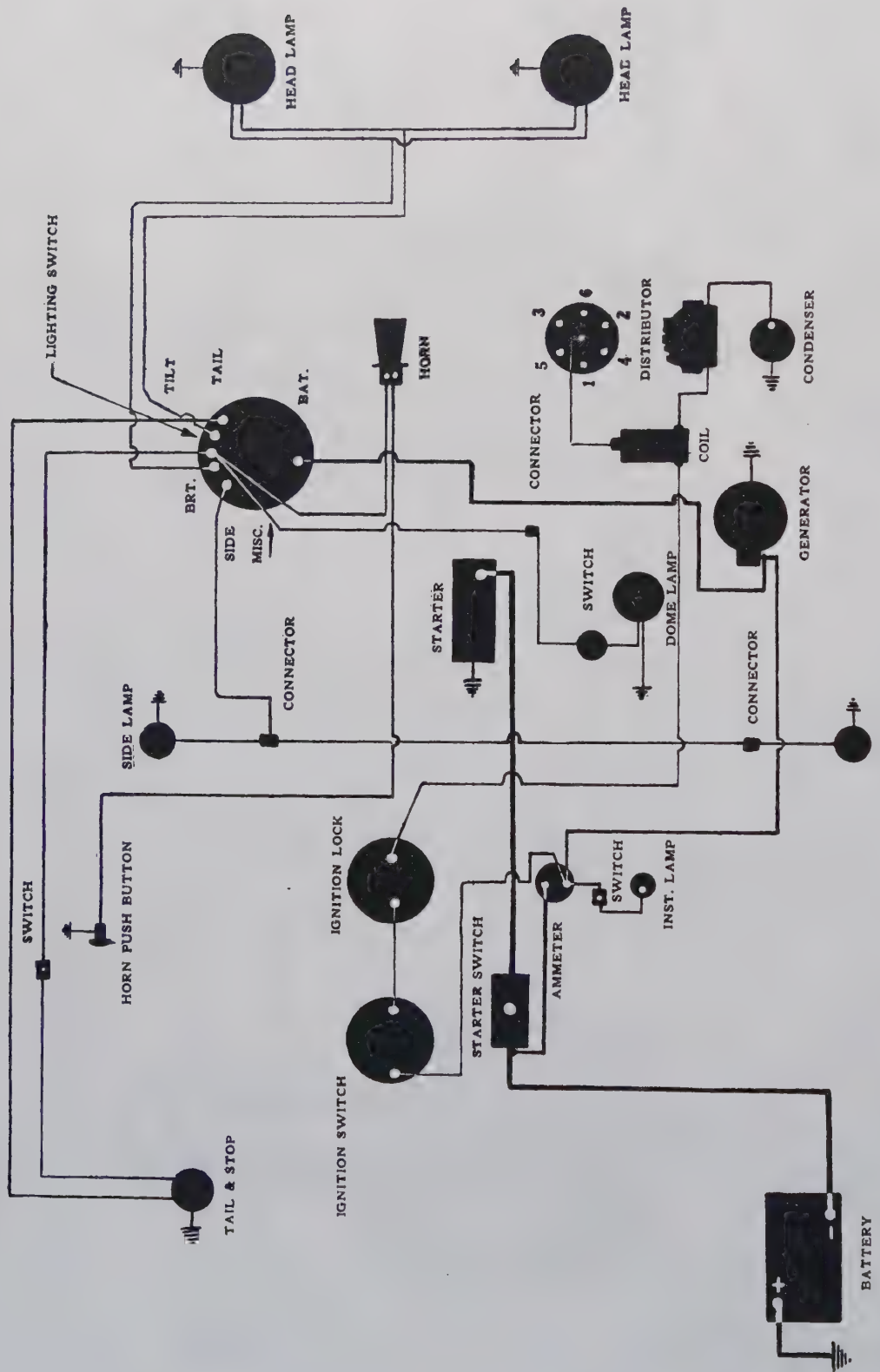
Illus. No. 57

Sectional View of Delco-Remy Distributor Used on the Big Six Models



Illus. No. 58

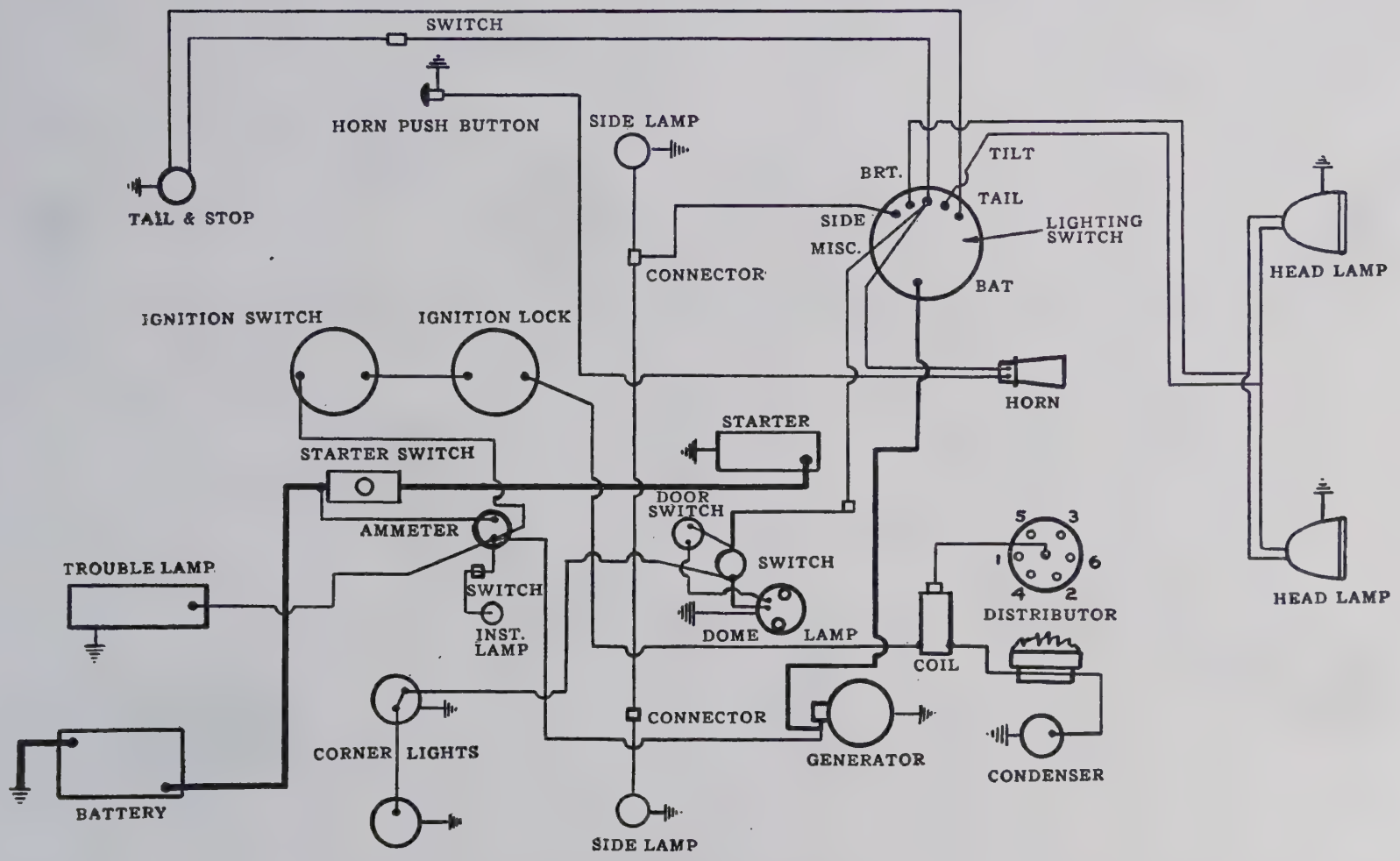
Sectional View of Delco-Remy Distributor Used on the Standard Six Models



Illus. No. 59
Car Wiring Diagram—Commander

PRINTED IN U. S. A.

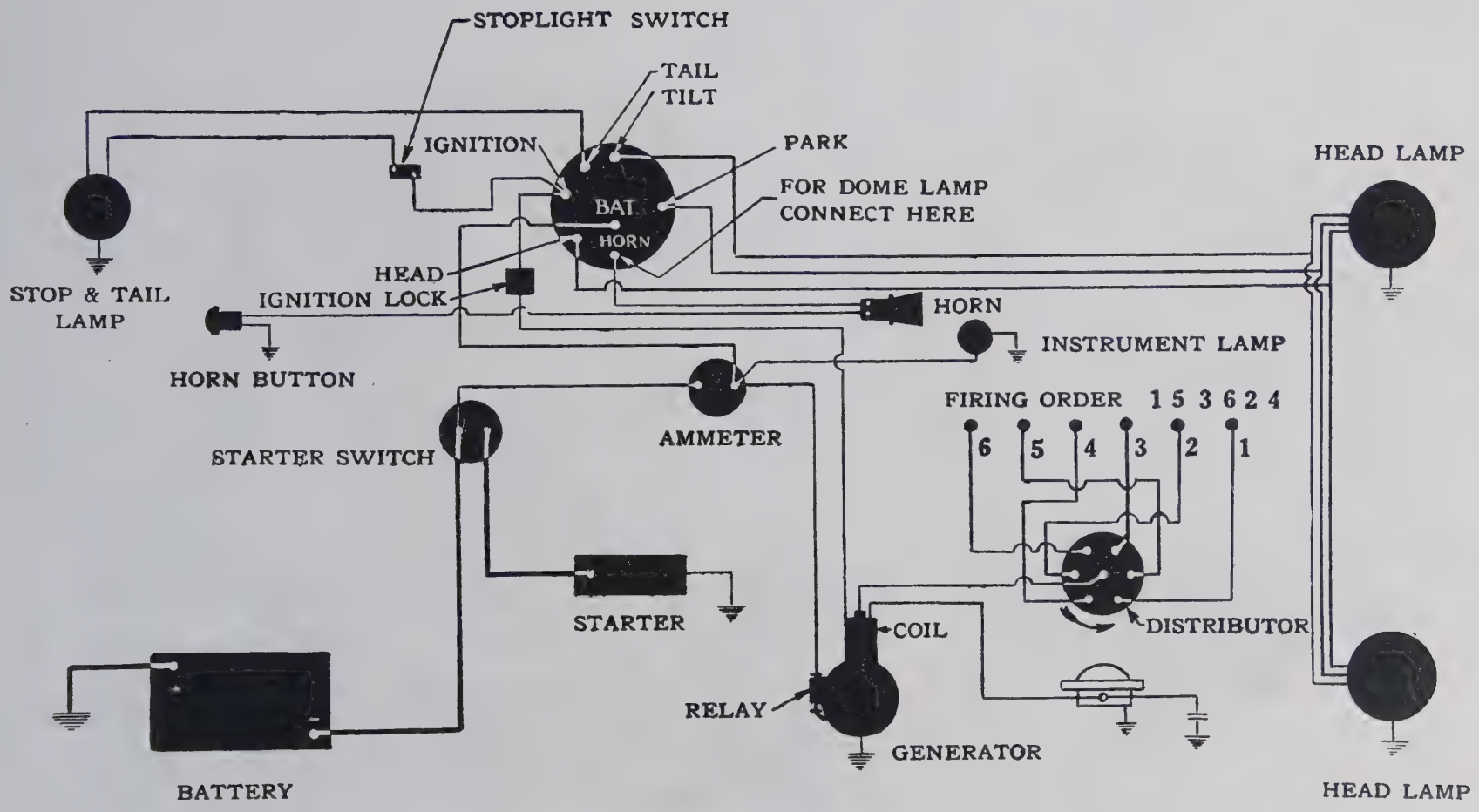
Issued October 15, 1927
Insert in Volume Seven, after page 78-B.



Illus. No. 60
Car Wiring Diagram—President

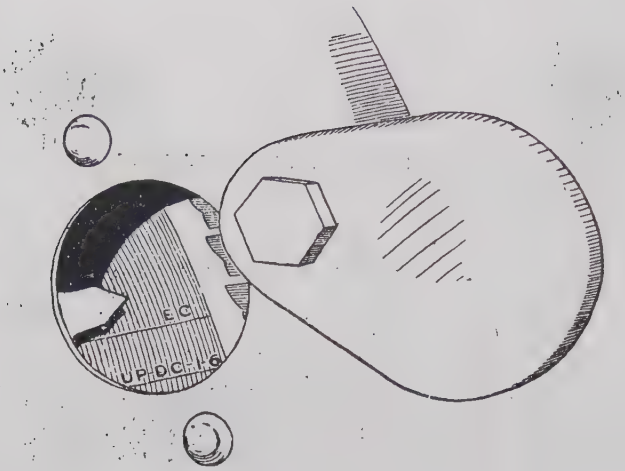
PRINTED IN U. S. A.

Insert in Volume Seven after page 78-C



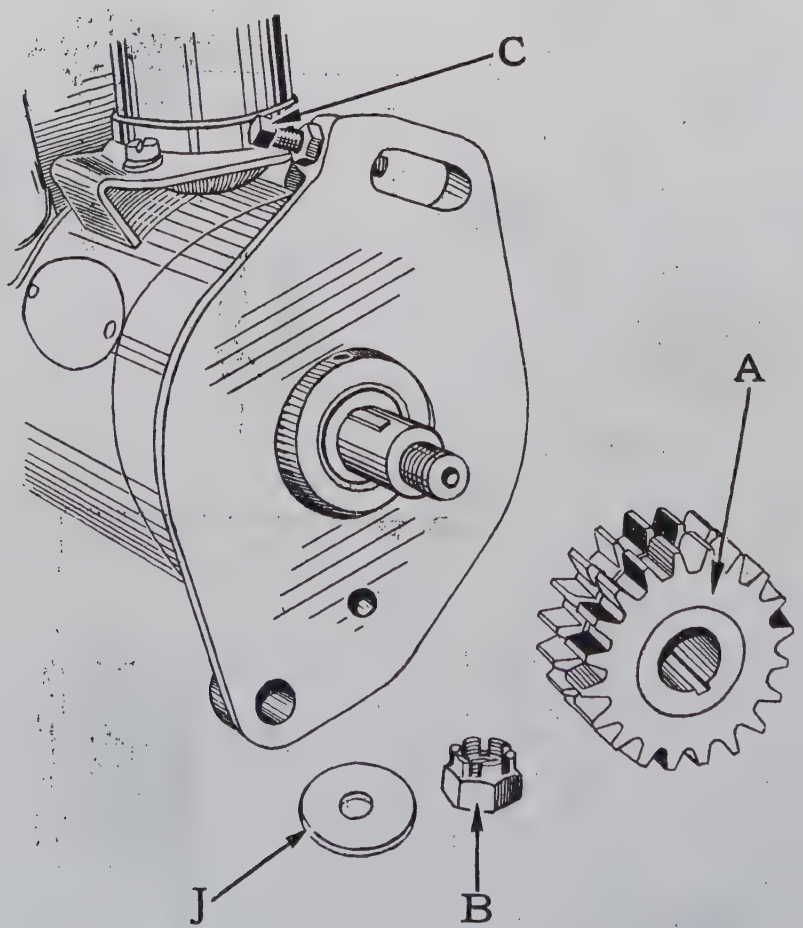
Illus. No. 61

Car Wiring Diagram—Erskine Six



Illus. No. 62

Flywheel Marks and Timing Hole—Erskine Six



Illus. No. 63

Generator and Sprocket—Erskine Six

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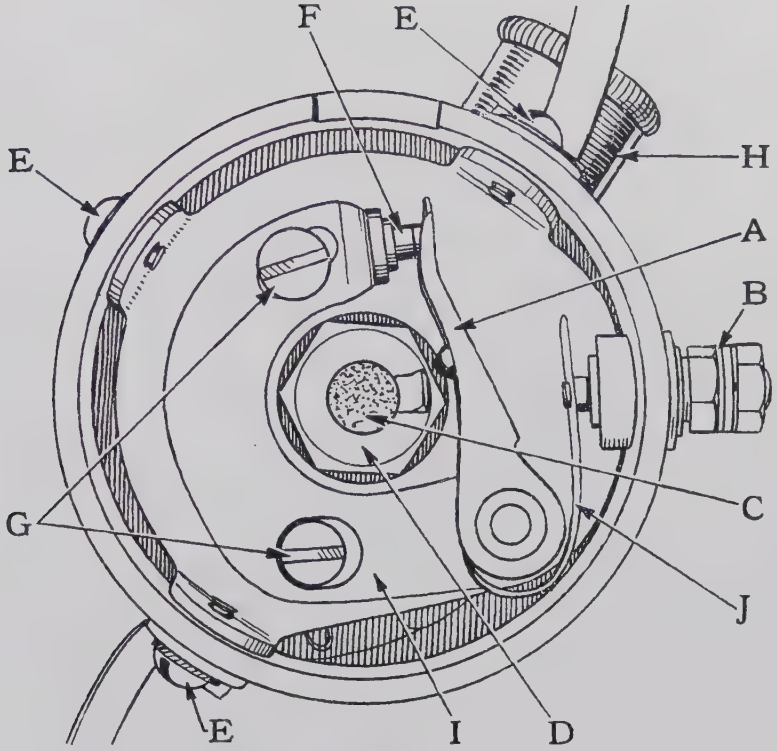
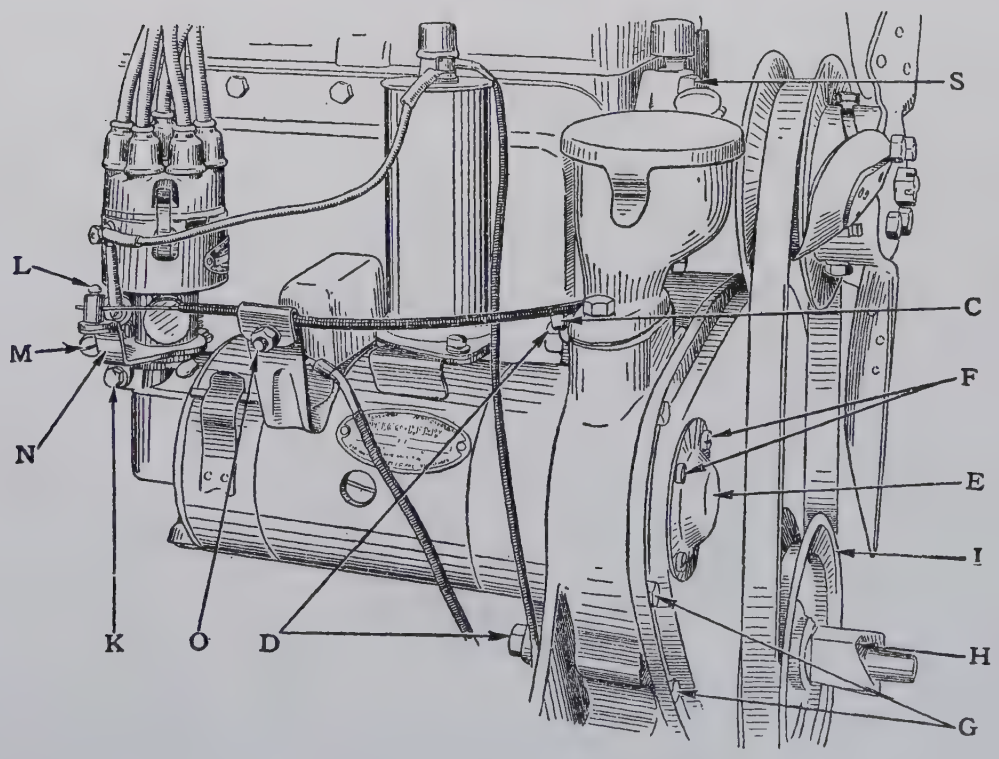
Insert in Volume Seven, After page 78-F



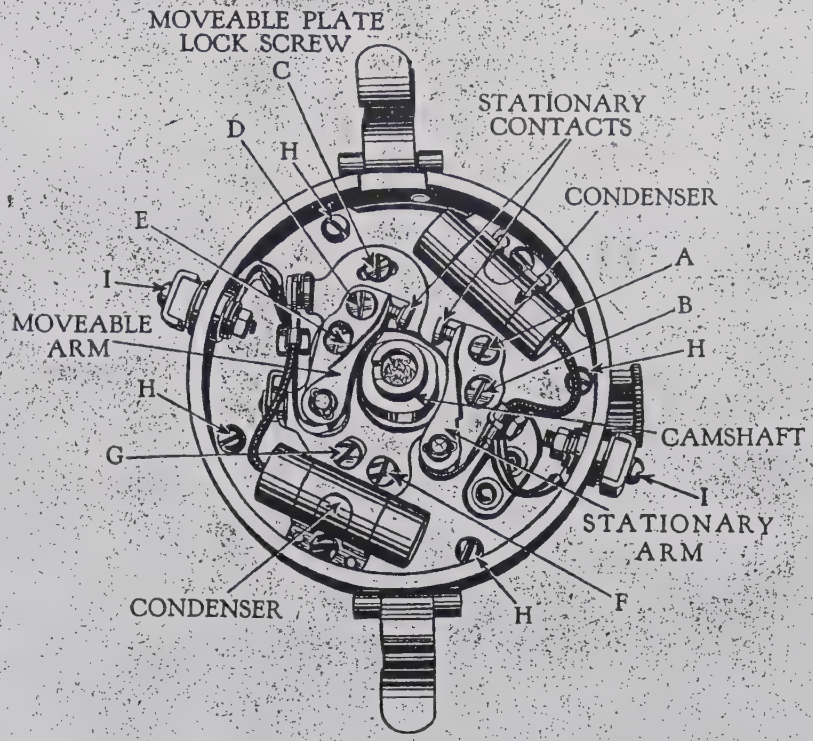
Illus. No. 64

Delco Remy Distributor—Erskine Six

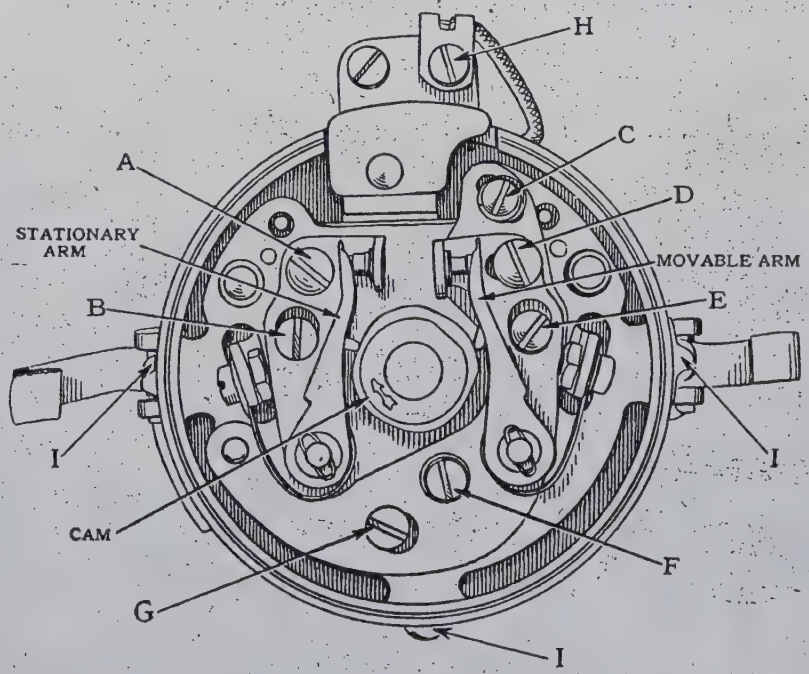


Illus. No. 65

Camshaft Chain Adjustment, Distributor and Generator—Erskine Six

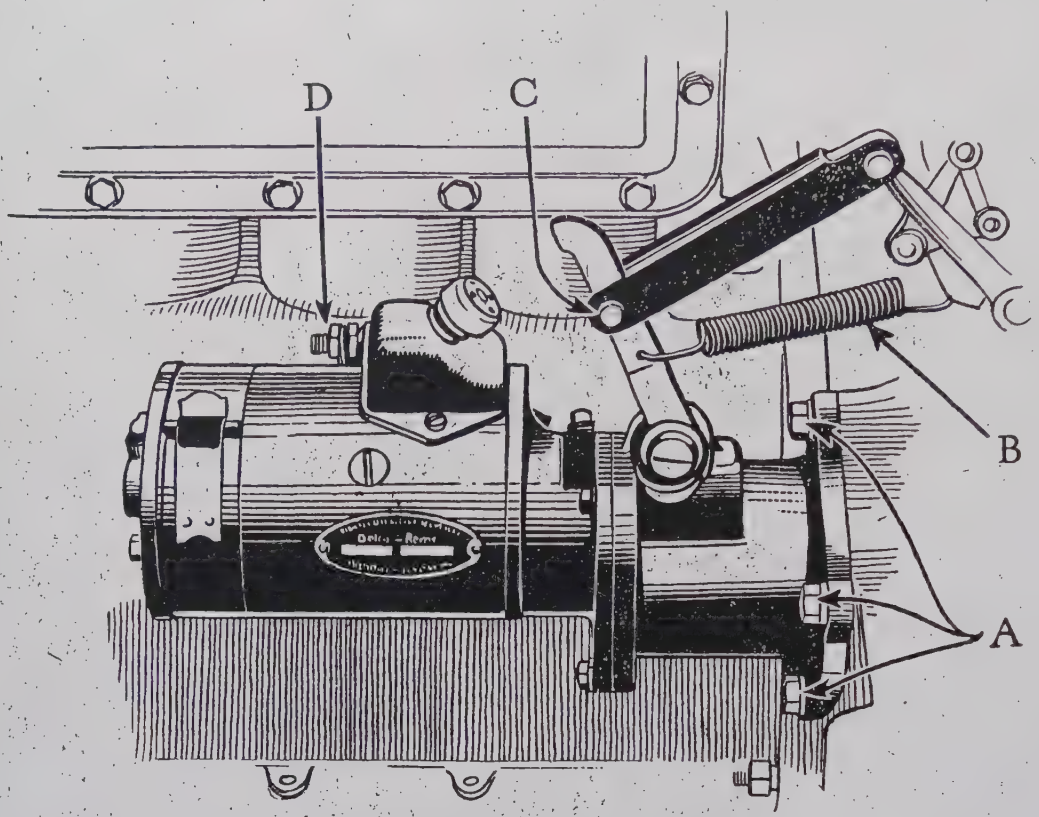


Illus. No. 66
Distributor Head—President Eight
(Double Coil)



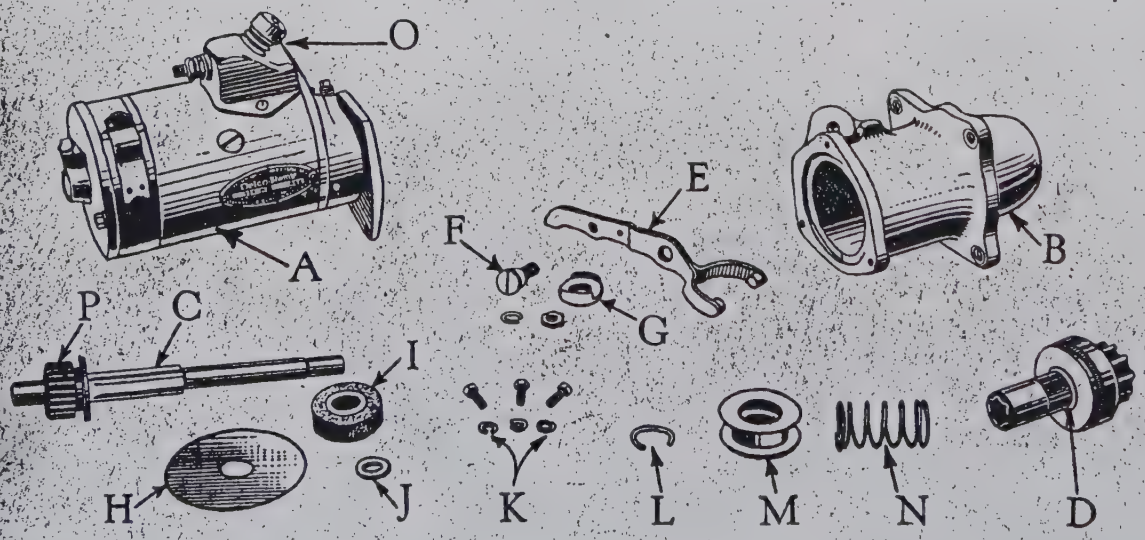
Illus. No. 67
Distributor Head—President Eight
(Single Coil)

Issued July 1, 1929
Insert in Volume Seven after page 78-G
PRINTED IN U. S. A.



Illus. No. 68

Starter Motor Assembled to Flywheel Housing—President Eight

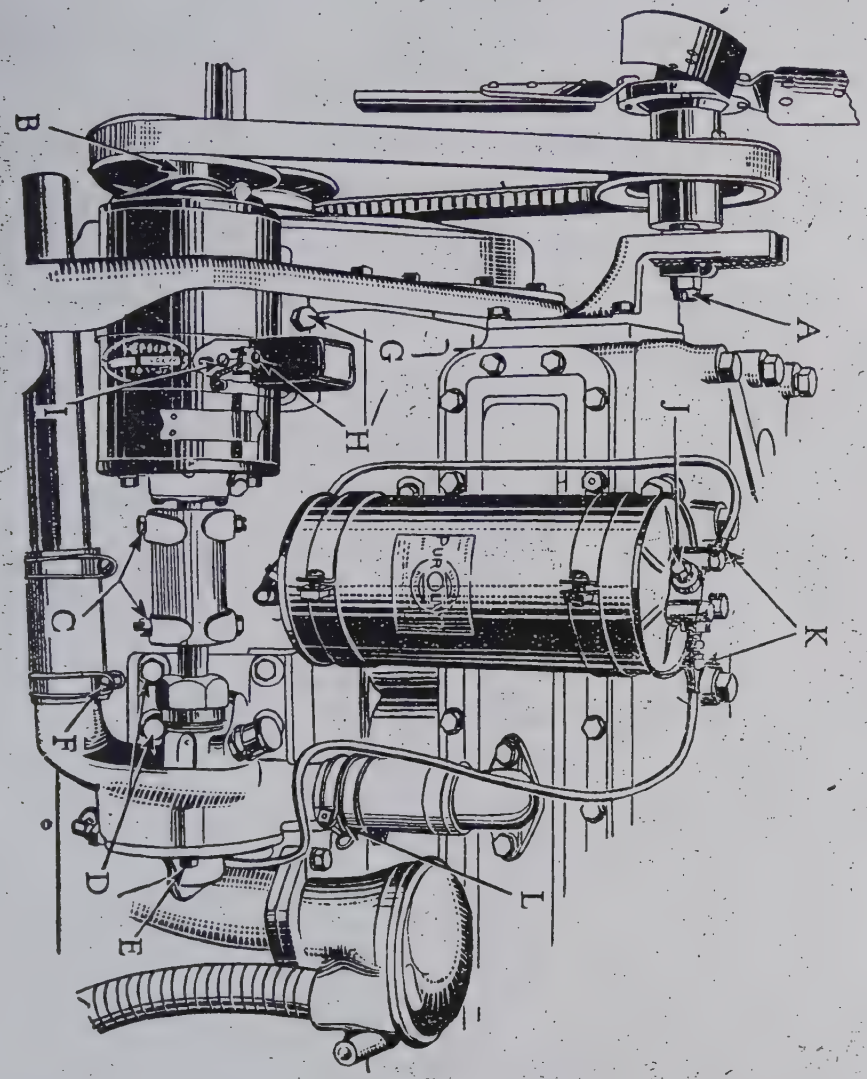


Illus. No. 69

Starter Motor Disassembled—President Eight

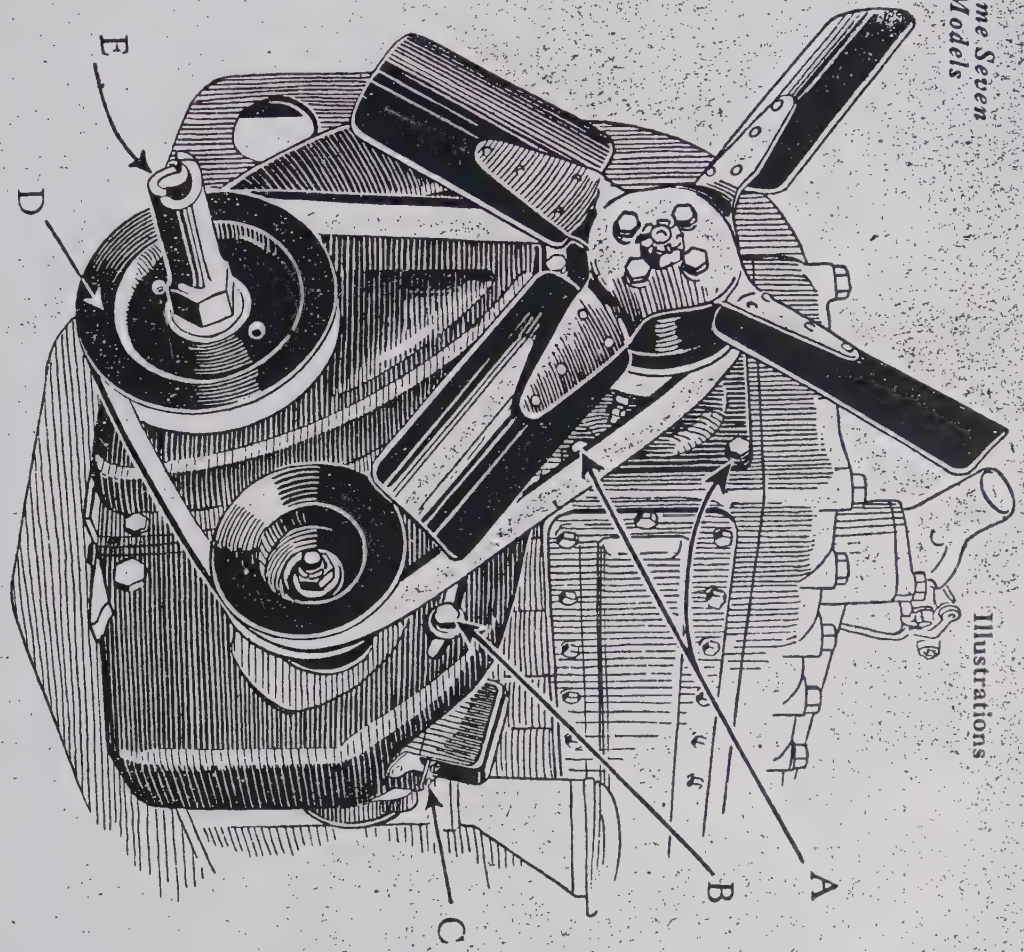
PRINTED IN U. S. A.

Issued July 1, 1929
Insert in Volume Seven after page 78-J



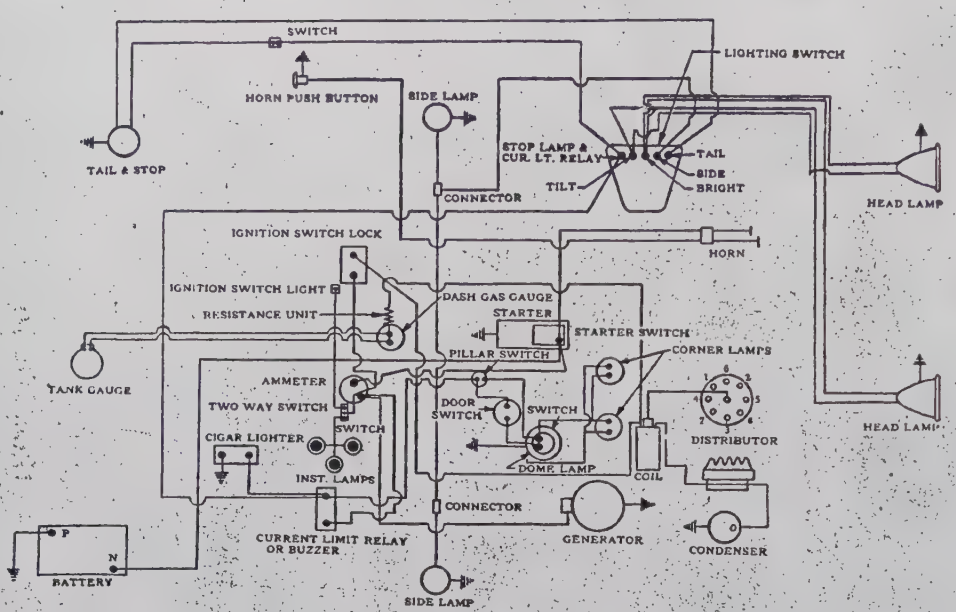
Illus. No. 71

Generator Assembled to Motor—President Eight

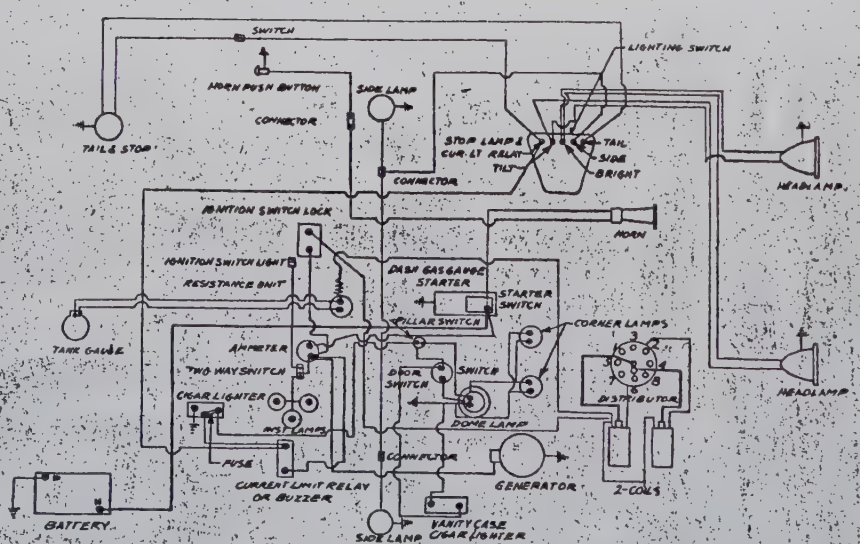


Illus. No. 70

Generator, Fan and Water Pump Assembly—President Eight



Illus. No. 72
Wiring Diagram—President Eight
(Single Coil)



Illus. No. 73
Wiring Diagram—President Eight
(Double Coil)

OPERATION ARTICLES

The following section is one containing instructions for disassembling, assembling and repairing various units. Revisions will from time to time be necessary and it is essential that the reader see both the original article and the revision. A system has therefore been devised making it difficult for the reader to overlook the latest instructions.

The original white sheets in this section have been cut one inch short. Revisions sent out on green sheets will extend below the white sheets in quarter inch steps. The number of the revised operation article will be carried at the bottom of the green sheet.

For example, the reader is interested in Operation Article No. 3, To Disassemble and Assemble Remy Distributor. Before he reads this, a glance at the bottom of the page will tell whether there are further instructions on the subject. If a green sheet extends below, carrying a variation of the Operation Article No. 3, such as 3-1 or 3-2, then he knows that the information on the green sheet must also be read to get the complete instructions.

ARTICLE No. 1

To Remove and Replace Ignition Distributor
Big and Special Six

If the car being worked on is not equipped with the self-adjusting fan, omit operations No. 1, 2 and 7.

1. Unscrew the fan belt adjusting wing nut "O" (Illus. No. 9).
2. Slide the fan belt off of the lower pulley.
3. Remove the distributor cap leaving the cables assembled.
4. Disconnect the distributor to ignition coil cable.
5. Remove two screws "R" as shown in Illus. No. 9.
6. The distributor can now be removed. See that none of the shims located at the bottom of the distributor bracket are lost.
7. Pull the cotter pin, unscrew the nut at "S" (Illus. No. 9), and remove the fan.
8. Reverse operations to assemble.
9. To check the backlash between the distributor gears on Wagner distributors, remove the following parts before bolting the distributor support in position for the test. Remove the distributor rotor and take out the screw holding the cam. Pry the cam off of the shaft with a screw driver. (Illus. No. 8). Remove four screws and lift off the top of the distributor. Unhook the two weight springs and lift out the distributor cam shaft. Now bolt the distributor support to the engine with the shims in place. Test the backlash by attempting to turn the distributor shaft as shown in Illus. No. 10. Remove or add shims, if necessary, to allow a slight movement of the shaft with the support screws drawn tight. When the correct backlash has been obtained, remove the support to assemble the parts to it.

To check the backlash on Remy distributors, bolt the distributor assembly to the engine with the shims in place. Remove the distributor rotor and unscrew the nut holding the cam. Pry the cam off of the shaft with a screw driver. (Illus. No. 8). Remove the two screws holding the base plate and lift off the plate. Unhook the two weight springs and lift out the distributor cam shaft. Check for backlash as above.

10. Time the spark. (See Operation Article No. 17).

Tools Required—Pliers, screw driver, No. 21, 25 and 27 open end wrenches.

ARTICLE No. 2

To Remove and Replace Ignition Distributor
Standard Six

1. Remove the distributor cap, leaving the cables assembled.
2. Disconnect the low tension cable.
3. Loosen the locating set screw on the side of the distributor bracket and lift off the distributor.
4. Observe the position of the distributor rotor so that the distributor can be replaced in the same position otherwise it will be necessary to retime the spark.
5. Reverse operations to replace.

If necessary to time the spark, see Operation Article No. 18.

Tools Required—Pliers, screw driver, No. 21 and 23 open end wrenches.

ARTICLE No. 3

To Disassemble and Assemble Remy Distributor
Remy Model 626-L, 626-S and 626-K Distributor
Big, Special and Standard Six

1. Remove the distributor. (See Operation Article No. 1 or 2).
2. Remove the rotor.
3. Remove the condenser.
4. Unscrew the cam retainer nut and pry the cam off with a screw driver. (Illus. No. 8).
5. Remove the two screws holding the circuit breaker base plate and remove the plate.

6. Unhook the two weight springs and lift out the distributor cam shaft.

7. Remove the coupling or gear at the lower end of the shaft by driving out the pin and pulling with a gear puller.

8. Remove the shaft by lifting upward through the housing.

9. Reverse operations to assemble.

Tools Required—Screw driver, pliers, No. 25 open end wrench, hammer, punch, gear puller.

ARTICLE No. 4

To Disassemble and Assemble Wagner Distributor

Wagner Model K-866, K-870 and K-815 Distributor
Big, Special and Standard Six

1. Remove the distributor. (See Operation Article No. 1 or 2).

2. Remove the rotor.

3. Remove the screw holding the cam and pry the cam off of the shaft with a screw driver (Illus. No. 8).

4. Remove the four screws and lift off the top of the distributor.

5. Unhook the two weight springs and lift out the distributor cam shaft.

6. Remove the coupling or gear at the lower end of the shaft by driving out the retainer pin and pulling with a gear puller.

7. Remove the shaft by lifting upward through the housing.

8. Reverse operations to assemble.

Tools Required—Screw driver, pliers, hammer, punch, gear puller.

ARTICLE No. 5

To Remove and Replace Generator

Big and Special Six

1. Turn off the terminal nut and remove the wire.

2. Turn out three cap screws "V" (Illus. No. 9) holding the generator in place.

3. Turn off nut "U", holding the generator to the bracket.

4. Loosen cap screw "T", holding the bracket to the cylinder block.

5. The generator can now be removed.

6. Reverse operations to replace, making sure the rubber bumpers are not cramped as in Illus. No. 23, and that the generator base sets flat on the bracket before tightening the fastening screws.

Tools Required—No. 25 open end wrench, 9/16 inch socket wrench.

ARTICLE No. 6

To Remove and Replace Generator

Standard Six

1. Remove the high tension wire and the two primary wires from the ignition coil.

2. Remove the two bolts holding the ignition coil to the bracket on the generator and lift off the coil.

3. Disconnect the battery wire from the relay.

4. Remove the three cap screws holding the generator to the accessory bracket.

5. The generator can now be removed.

6. Reverse operations to replace.

Tools Required—Screw driver, pliers, No. 25 open end wrench.

ARTICLE No. 7

To Disassemble and Assemble Remy Generator

Remy Models 917-A and 917-E Generator
Big, Special and Standard Six

1. Remove the generator. (See Operation Article No. 5 or 6).

2. Remove the commutator shield.

3. Remove the through bolts (Illus. No. 13).

4. Remove the dust cap on the commutator end.

5. Remove the ball bearing retainer nut or clip at the commutator end.
6. Remove the drive end bearing and armature.
7. Pull the coupling with a gear puller.
8. Remove the drive end bearing from the armature.
9. Disconnect the field leads from the brushes and remove the commutator housing.
10. Reverse operations to assemble.

Tools Required—Screw driver, pliers, 9/16 inch socket wrench, hammer, gear puller, No. 25 open end wrench.

ARTICLE No. 8

To Disassemble and Assemble Wagner Generator

Wagner Models, S-508 and S-509

Big, Special and Standard Six

1. Remove the generator. (See Operation Article No. 5 or 6).
2. Remove the commutator shield.
3. Remove the through bolts (Illus. No. 14).
4. Remove the drive end bearing and armature.
5. Pull off the coupling, using a puller or small arbor press.
6. Remove the drive end bearing from the armature.
7. To remove the commutator end bearing remove three screws and take off the front end shield.
8. Reverse operations to replace.

Tools Required—No. 25 open end wrench, screw driver, hammer, universal puller.

ARTICLE No. 9

To Remove and Replace Starter Motor

Big and Special Six

1. Turn off the two cable nuts on the side of the starter motor and remove the cables.
2. Remove the locking wire in the master link of the chain shown at "C" (Illus. No. 9).
3. Take out the master link in the chain.
4. Loosen the starter motor clamp screw "B".
5. Pull the cotter pin in pin "A" holding the starter motor to the crank case.
6. Drive out the pin holding the starter motor to the crank case.
7. The starter motor can now be removed.
8. Reverse operations to replace.

Tools Required—Pliers, screw driver, No. 27 open end wrench, starter fastening screw wrench.

ARTICLE No. 10

To Remove and Replace Starter Motor

Standard Six

1. Disconnect the starter motor cable.
2. Remove the three cap screws holding the starter motor to the flywheel housing.
3. The starter motor can now be removed.
4. Reverse operations to assemble.

Tools Required—No. 25 and 27 open end wrenches, pliers.

ARTICLE No. 11

To Disassemble and Assemble Remy Starter Motor

Remy Model 720-M Starter Motor

Standard Six

1. Remove the starter motor. (See Operation Article No. 10).
2. Remove the through bolts. (See Illus. No. 27).

3. Remove the Bendix housing.
4. Remove the armature.
5. Disconnect the field leads and remove the commutator housing.
6. Remove spring screw "C" (Illus. No. 27) after which Bendix drive can be removed.
7. Reverse operations to assemble.

Tools Required—Pliers, screw driver, No. 25 open end wrench.

ARTICLE No. 12

To Disassemble and Assemble Remy Starter Motor

Remy Model 723-A Starter Motor

Big and Special Six

1. Remove the starter motor. (See Operation Article No. 9).
2. Remove the through bolts as in Illus. No. 24.
3. Remove the armature and gear case assembly.
4. Remove the gear case cover.
5. Drive out the sprocket pin and remove the sprocket.
6. Remove the gear and countershaft.
7. Disconnect the field leads from the brushes and remove the commutator housing.
8. Reverse operations to replace.

Tools Required—No. 21 open end wrench, screw driver, hammer, punch.

ARTICLE No. 13

To Disassemble and Assemble Wagner Starter Motor

Wagner Model S-503 Starter Motor

Big and Special Six

1. Remove the starter motor. (See Operation Article No. 9).
2. Remove the commutator shield. (Illus. No. 24).
3. Remove the through bolts.
4. Remove the gear case and armature.
5. Remove the screws holding the gear case cover and remove the cover with the gear and sprocket.
6. Remove the armature.
7. Drive out the pin holding sprocket "B" (Illus. No. 24) and remove the sprocket and gear, using a puller.
8. Disconnect the field coils.
9. Remove the field coils and front end shield.
10. Take out the brush assembly.
11. Reverse operations to assemble. Adjust screw "A" (Illus. No. 24) so that the armature is perfectly free but has no end play.

Tools Required—No. 25 open end wrench, pliers, screw driver, punch, hammer, universal puller.

ARTICLE No. 14

To Disassemble and Assemble Wagner Starter Motor

Wagner Model S-533 Starter Motor

Standard Six

1. Remove the starter motor. (See Operation Article No. 10).
2. Remove the commutator shield (Illus. No. 26).
3. Remove the through bolts.
4. Take off the Bendix housing.
5. Take out the armature.
6. Remove screw "A" (Illus. No. 26) and remove the Bendix assembly from the shaft.
7. Disconnect the field leads.
8. Remove the field coils and front end shield.
9. Take out the brush assembly.
10. Reverse operations to assemble.

Tools Required—No. 25 and 27 open end wrenches, pliers, screw driver, hammer.

ARTICLE No. 15

To Prepare Willard Bone Dry Battery for Service

The following instructions must be observed carefully when Willard Threaded Rubber "Bone Dry" batteries are prepared for service. Special attention is called to the fact that these batteries require no initial charging and can be put in service two hours after adding electrolyte.

1. Remove the soft rubber nipples which are placed over the vent plugs. These nipples should be discarded as they must not be used after the battery has been prepared for service.

2. Remove the hard rubber vent plugs and fill each cell to a level one inch above the insulators, with 1.290 specific gravity electrolyte. (Illus. No. 32). (See "preparing Electrolyte," page 46).

Use only glass, hard rubber or lead containers for pouring the electrolyte into the cells and see that it has cooled to 90° F.

3. Replace the hard rubber vent plugs on the cells. If any electrolyte was spilled on the battery it can be removed by means of a cloth slightly dampened with a weak solution of ammonia.

4. After the battery has been allowed to stand two hours after filling with electrolyte, it may then be placed in service.

5. After approximately 24 hours, the level of the electrolyte will fall. If it is lower than 3/8 of an inch over the insulators it must be adjusted by adding *distilled water* to the cells.

ARTICLE No. 16

To Remove and Replace Lighting Swith
Big, Special and Standard Six

1. Remove the thumb screw and take off the light switch cover.

2. Remove the screws holding the cable terminals to the lighting switch and remove the cables and conduit. On cars which have the dimmer resistance unit mounted on the instrument board it will also be necessary to disconnect the two wires leading to it.

3. Loosen the clamp screws holding the lighting switch and the gear at the lower end of the switch and remove the lighting switch and gear.

4. Reverse operations to replace.

Before replacing the switch, pull the lighting switch lever on the steering wheel clear down so that the word "curb" on the lever hub is at the top. Turn the shaft on the lighting switch clockwise (viewed from the top) as far as possible. Put the switch in place with the conduit hole to the inside and with the gear on the lower end of the shaft turned clockwise so as to engage the last tooth with the corresponding tooth of the gear on the lighting switch lever tube.

Then complete operations 3, 2 and 1.

Tools Required—No. 23 and 25 open end wrenches, screw driver.

ARTICLE No. 17

To Time the Spark
Big and Special Six

1. Open the priming cup on No. 1 cylinder and crank the engine by hand until No. 1 piston has begun its compression stroke, which can be detected by holding the thumb over the priming cup until compression is felt.

2. Continue to crank the engine until the mark "UP-DC-1-6" on the flywheel comes under the timing pointer in the left-hand side of the flywheel housing. (Illus. No. 36).

3. Loosen the screw on Wagner Equipment or the nut on Remy equipment which holds the cam on the tapered shaft.

4. Pry up the cam with a screw driver as shown in Illus. No. 8.

5. Turn the cam in a counter-clockwise direction until it reaches a position such that when all parts are assembled, the edge of the rotor segment comes directly under No. 1 distributor cover termi-

nal and the breaker points are just in the act of breaking.

6. Tighten the lock screw or nut in this position and replace the rotor and distributor cap.

7. The firing order is 1-5-3-6-2-4. See that the wires leading to the spark plugs follow No. 1 in that order, in a counter-clockwise direction around the distributor cap.

Tools Required—Pliers, screw driver, No. 25 open end wrench.

ARTICLE No. 18

To Time the Spark

Standard Six

1. Remove No. 1 spark plug and crank the engine by hand until No. 1 piston has begun its compression stroke which can be detected by holding the thumb over the spark plug hole until compression is felt.

2. Continue to crank the engine until the mark "UP-DC-1-6" on the flywheel comes under the timing pointer in the right-hand side of the flywheel housing. (Illus. No. 38).

3. Loosen the screw on Wagner equipment or the nut on Remy equipment which holds the cam on the tapered shaft.

4. Pry up the cam with a screw driver as shown in Illus. No. 8.

5. Turn the cam in a counter-clockwise direction until it reaches a position such that when all parts are assembled, the edge of the rotor segment comes directly under No. 1 distributor cover terminal and the breaker points are just in the act of breaking.

6. Tighten the lock screw or nut in this position and replace the rotor and distributor cap.

7. The firing order is 1-4-2-6-3-5. See that the wire leading to the spark plugs follow No. 1 in that order, in a counter clockwise direction around the distributor cap.

Tools Required—Pliers, screw driver, No. 25 open end wrench.

ARTICLE No. 19

To Remove Inspection Lamp

1. Reach under the instrument board and disconnect the wire at the fuse terminal "I" (Illus. No. 47).

2. Pull the lamp out a short distance and pull the switch "J" (Illus. No. 46) to hold it.

3. Unscrew the glass and reflector "H" (Illus. No. 47) from the socket and remove the bulb so that it will not be broken.

4. Unscrew the cover bushing "G" (Illus. No. 48) by means of the slots "L" in the bushing. A Big and Special Six water pump packing nut wrench can be used by bending the points together slightly until they fit into the slots in the bushing as shown in Illus. No. 46.

5. The cover bushing "G" (Illus. No. 47) can now be removed by sliding it over the socket.

6. Unscrew the switch button bushing "C" (Illus. No. 46) and remove the inspection lamp assembly from the instrument board as shown in Illus. No. 47.

Tools Required—Pliers, 21 open end wrench, Big and Special Six water pump packing nut wrench.

ARTICLE No. 20

To Disassemble Inspection Lamp

1. Remove the inspection lamp from the instrument board. (See Operation Article No. 19).

2. Remove the four screws holding the cover "A" (Illus. No. 48) and remove the cover.

3. Unhook the spring lever "B" at "E" and bend it up slightly allowing the spring to release.

4. Remove the screw at spring lever "B" and remove the lever.

ARTICLE No. 17-1

To Time the Spark

(*Big Six Engine Models.*)

The following revision in Article No. 17 *applies to Big Six cars having the manual spark and heat controls on the instrument board.*

1. Remove the spark plug or priming plug No. 1 cylinder and crank the engine over by hand until No. 1 piston has begun its compression stroke, which can be detected by holding the thumb over the priming plug or spark plug hole until compression is felt.

2. Continue to crank the engine until the mark "UP-DC-1-6" on the flywheel comes under the timing pointer in the left hand side of the flywheel housing. (Illus. No. 36).

3. Remove the distributor cover without disconnecting the wires. With the spark lever on the instrument board set in a position half-way between the advance and retard marks, the rear edge of the spark control arm should be lined up with the mark on the distributor housing (Illus. No. 57). If the control arm does not line up with this mark, loosen the set screw which fastens the spark control wire at the distributor and move the arm until it lines up with the mark and tighten the set screw.

4. Loosen the lock nut which holds the cam on the tapered shaft and pry up the cam with a screw driver as shown in Illus. No. 8.

5. Turn the cam in a counter-clockwise direction until it reaches such a position that when all parts are assembled, the edge of the rotating segment comes directly under No. 1 distributor cover terminal and the breaker points are just in the act of breaking.

6. Tap the cam down and tighten the lock nut. Replace the distributor cover.

Tools Required—Screw driver, pliers and No. 25 open end wrench.

ARTICLE No. 18-1

To Time the Spark

(*Standard Six*)

The following revision in Operation Article No. 18 *applies to Standard Six cars having the spark and heat controls on the instrument board.*

1. Remove No. 1 spark plug and crank the engine by hand until No. 1 piston is on upper dead center of its compression stroke, and the mark "UP-DC-1-6" on the flywheel is under the pointer in the right side of the flywheel housing. (Illus. No. 38).

2. Set the spark lever on the instrument board half-way between the fully advanced and retarded positions.

3. The mark on the front of the distributor control arm plate should then line up with the mark on the distributor shaft housing directly below the plate. If the marks on the plate and housing do not line up, loosen the screw fastening the control wire to the control arm and move the control arm plate just to the point where the mark on the plate is directly above the mark on the housing. Tighten the fastening screw.

4. Remove the distributor cover, leaving the wires attached. Then loosen the clamp bolt in the control arm plate and rotate the distributor to such a point that when all parts are assembled, the edge of the rotating segment comes directly under No. 1 distributor cover terminal and the breaker points are just in the act of breaking.

5. Tighten the clamp bolt in the control arm plate and replace the distributor cover.

Tools Required—Pliers, screw driver and No. 25 open end wrench.

Issued October 15, 1927
Insert in Volume Seven, after page 86.

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5. Bend up the four clips "K" holding cover "D" and pry off the cover.

6. The reel, cord and socket assembly "F" can now be removed by taking out the remaining set screw in the reel shaft.

7. Reverse operations to assemble.

Make sure the reel is placed in the housing with the notched side corresponding with the switch lever catch.

When the assembly is complete, turn the spring lever "B" to the right (clockwise) four times and hook it under one of the clips "E".

Tools Required—Small screw driver, pliers, hammer.

ARTICLE No. 21

To Adjust and Focus Headlamps

The following operations are to be used when focusing headlamps having the dimmer resistance unit. (*See operation Article No.* 22 *to focus the double filament headlamps*).

1. Remove the cover and lense from the headlamps.

2. Place the car on a level floor or level ground so that the headlamp beams will project upon a flat surface perpendicular to the axis of the beam, at a distance of about twenty-five feet.

3. Turn the screw in the rear of the lamp body in or out until the smallest spot of light obtainable is thrown on the distant surface. The lamp filament will then be at the focal point of the reflector. The appearance of the spot of light projected by each head lamp should in this case be approximately as shown in Illus. No. 44, Fig. 1.

If the lamp is too far ahead or behind the focal point, the spot will appear about as in Fig. 2.

4. With the lamps in focus, the centers of these spots of light should be at the same height as the centers of the headlamps themselves. This adjustment can be made by loosening the lamp bracket clamp and twisting the lamp so the rays are thrown straight ahead and at the correct height.

5. Replace the cover and lense. The two headlamps should now give a spot as shown in Fig. 3.

Tools Required—Screw driver and adjustable wrench.

ARTICLE No. 22

To Adjust and Focus Headlamps

The following operations are to be used when focusing the double filament head lamps. (*See Operation Article No.* 21 *to focus head lamps having the dimmer resistance unit*).

1. Place the car, with the rear seat fully loaded, on a level floor or level ground with a garage door or other light colored vertical surface twenty-five feet ahead.

2. Draw a horizontal line on this vertical surface at the level of the headlamp centers.

3. Sight through the center of the rear window over the radiator cap and so determine a point on the horizontal line midway between the headlamps. Locate points at the right and left of this center point directly ahead of the center of each headlamp. Draw vertical lines through these positions.

4. Place the lighting switch on the position marked "Bright" and cover one headlamp to obscure the light beam.

5. Turn the focus adjusting screw in the back of the uncovered lamp until the beam, having a high intensity at the top and a sharp upper outline, is as narrow as possible measured from top to bottom.

6. Loosen the lamp bracket clamp bolt and aim the lamp so that the top of the beam coincides with the horizontal line on the vertical surface and is equally divided by the vertical line directly ahead of the lamp center. In this position tighten the bracket clamp bolt securely. The beam should now appear as in Illus. No. 45, Fig 3.

7. Repeat the above operations for the other lamp and the headlamps will be properly adjusted. No further attention is required for the lower beams.

One point that must be kept in mind is that the top of the beam should cut off as sharply as possible. Results frequently can be improved by turning the bulb over in the socket when the beam is not satisfactory with the bulb as first installed.

Tools Required—Screw driver and adjustable wrench.

ARTICLE No. 23
To Remove and Replace Ignition Distributor
(Erskine Six)

1. Remove the distributor cap, leaving the cables assembled.
2. Disconnect the low tension cable from the distributor.
3. Disconnect the spark advance control wire at "L" (Illus. No. 65).
4. Remove the bolt "K" which holds the distributor assembly down in the generator.
5. The distributor can now be removed. Observe the position of the distributor rotor so that the distributor can be replaced in the same position otherwise it will be necessary to retime the spark.
6. Reverse operations to replace.

Tools Required—Screw driver and pliers.

ARTICLE No. 24
To Disassemble and Assemble Delco-Remy Distributor Delco-Remy Model 637 Y
(Erskine Six)

1. Remove the distributor. (See Operation Article No. 23).
2. Remove the rotor.
3. Lift off the breaker point arm.
4. Remove the three screws "C" (Illus. No. 64) holding the breaker plate in the distributor base.
5. The breaker plate can be removed by turning it counter clockwise so as to clear the breaker arm connection and lifting it out.
6. Unhook the two weight springs and lift out the distributor camshaft.
7. Remove the gear at the lower end of the shaft by driving out the pin and pulling with a gear puller.
8. Remove the shaft by lifting upward through the housing.
9. Reverse operations to assemble.

Tools Required—Screw driver, pliers, hammer, punch and a gear puller.

ARTICLE No. 25
To Remove and Replace Starter Motor
(Erskine Six)

1. Disconnect the starter motor cable.
2. Remove the three bolts holding the starter to the engine support and flywheel housing.
3. The starter can now be removed by sliding toward the radiator and lifting it out.
4. Reverse operations to replace.

Tools Required—No. 25 open end wrench and pliers.

ARTICLE No. 26
To Remove and Replace Delco-Remy Generator
(Erskine Six)

1. Disconnect the ignition coil primary cable.
2. Disconnect the cable from the generator relay.
3. Disconnect the spark advance control tube and wire from the generator bracket and distributor arm.
4. Remove the high tension cable from the coil, and unfasten the distributor cover and lay to one side.
5. By unscrewing the four screws "F" (Illus. No. 65) the inspection plate "E" can be removed.
6. Remove the cotter key and turn off the nut "B" (Illus. No. 63). Be sure to remove the plain washer "J" or it will drop down in the cover when the generator is removed.
7. Loosen the lock nut on the adjusting screw "C" (Illus. No. 63) and back off the screw until the adjustment is released.
8. Remove the two bolts "D" which hold the generator to the camshaft chain housing.
9. Pull the generator toward the rear of the car and remove.
10. Reverse operations to assemble. It is advisable to use a new generator to housing gasket.

When replacing the generator, the key in the shaft should be lined up with the keyway in the sprocket before the generator is entered in the housing, because the generator sprocket can not be turned.

Issued February 1, 1928
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PRINTED IN U. S. A.

If necessary to time the spark, see Operation Article No. 27.

Tools Required—Screw driver, pliers, No. 25, 27 and 29 open end wrenches, brass drift and hammer.

ARTICLE No. 27

To Time the Spark

(Erskine Six)

1. Remove No. 1 spark plug and crank the engine by hand until No. 1 piston has started up on the compression stroke. This can be determined by holding the thumb over the spark plug hole.

2. Remove the cover from the opening in the left side of the flywheel housing and have someone crank the engine over slowly until the marking "UP-DC-1-6" comes under the pointer in the opening. (Illus. No. 62).

3. Set the spark lever on the steering in the half way position and remove the distributor cover, leaving the wires attached.

4. Loosen the clamp bolt "M" (Illus. No. 65) on the control arm "N" which will leave the distributor free to be turned.

5. Now turn the distributor until it reaches such a point that when all parts are assembled, the edge of the rotor comes directly under No. 1 cover terminal position and the breaker points are just in the act of breaking. Care should be taken to see that the control arm "N" is in the half way position, otherwise the control arm screw "L" (Illus. No. 65) should be loosened and the control arm moved along the control wire to the proper position.

6. If it is necessary to turn the distributor excessively to make the adjustment, raise the distributor until the drive gears are out of mesh and turn the rotor so an approximate adjustment is obtained and remesh the gears.

7. Repeat operation 5 to obtain an accurate adjustment and tighten the clamp bolt "M" on the distributor control arm.

8. Replace the rotor and the distributor cover. The firing order is 1-5-3-6-2-4. See that the wires leading to the spark plugs follow No. 1 in that order in a counter clockwise direction around the distributor cap.

Note—The breaker points should be examined for the proper gap of .020 of an inch and should have a clean frosted appearance on their contact surfaces. These points should be inspected and taken care of before attempting to time the spark.

Tools Required—No. 23 and 25 open end wrenches, screw driver, pliers, spark plug wrench and crank.

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